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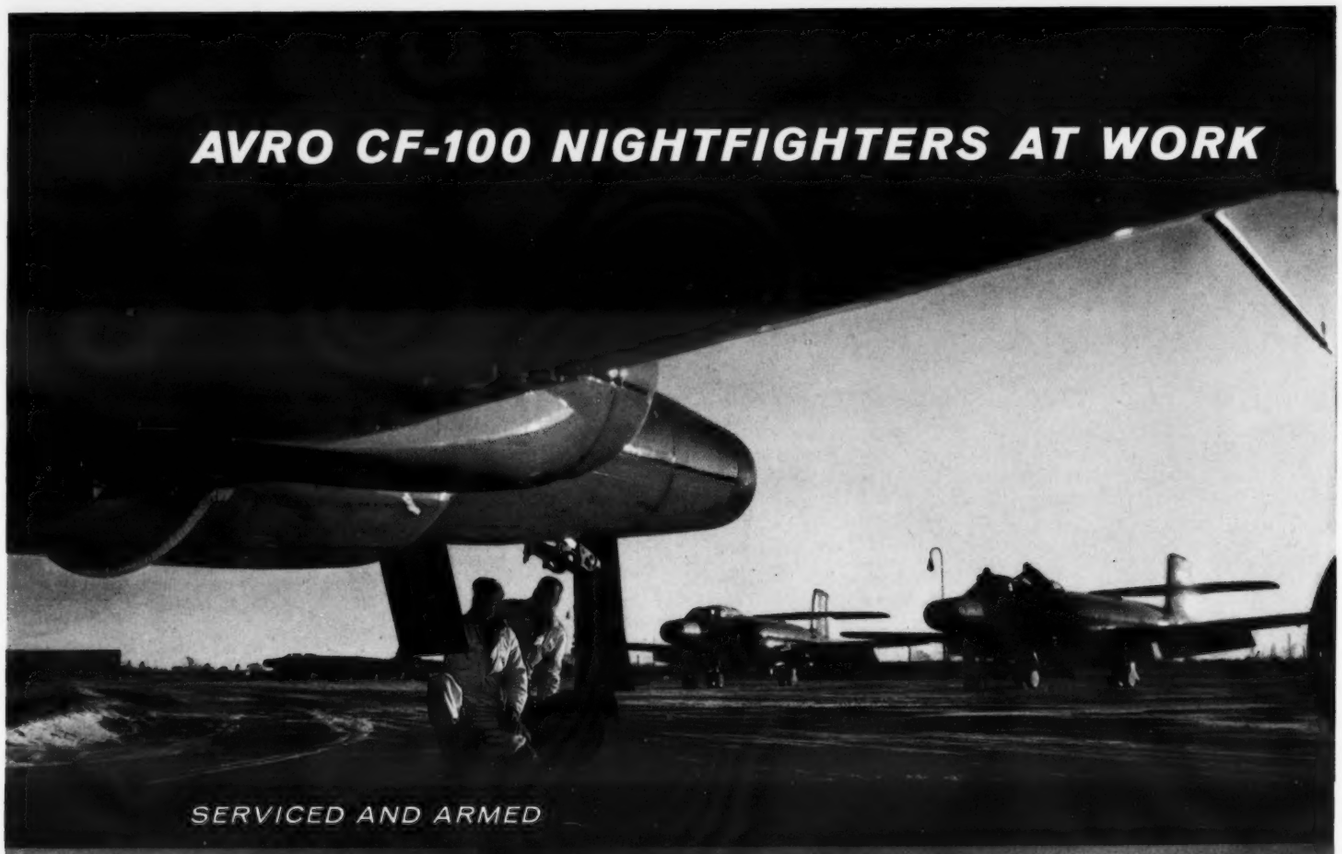
IN THIS ISSUE

Air Transport:

New Vistas are Opening

VOLUME XII 4 APRIL 1957

AVRO CF-100 NIGHTFIGHTERS AT WORK



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INTERAVIA

Review of World Aviation

Volume XII **No. 4** **April 1957**

Contents

AIR TRANSPORT VISTAS

There is no Need for Panic about the Jet Transport Age Sir W. P. HILDRED, MONTREAL 293
Future Airport Requirements . . . . . J. T. PYLE, WASHINGTON 295
European Air Transport . . . . . B. BJÖRKMAN, BRUSSELS 297
U.S. Airlines Anticipate Mass Travel by Turbine Aircraft S. G. TIPTON, WASHINGTON 299
Flying the Boeing 707 Jet Transport . A. M. JOHNSTON, SEATTLE 305
Flight Testing the Caravelle 308
A Pilot's Impressions of the Friendship . . L. W. KILLEN, GENEVA 310
The Lockheed Electra 311
Towards the Supersonic Airliner 317

Stalking from Brussels to Paris 320
U.S. Air Power in the Cross-Fire of the Symington Committee 322
The C-132 Super Transport 324
Top Priority for the I.C.B.M. 329
World Air Power No. 4 331
What's in the Air ? 334
The Tupolev Bear's Propeller Turbines . . . . . F. BRANDNER, GRAZ 337
The Boucher Fog Dispersal System 339
Air Transport Inventory for the Jet Age 341
Book Reviews 342
The Mind of Mr. Reader 262

Front Cover:

Cool as a Cocktail Club. Modern airports are paying increasing attention to the comfort of passengers on the ground. This colour photo by John A. Stryker shows the air-conditioned passenger lobby of the air terminal at Amon Carter Field, the airport of the thriving city of Fort Worth in Texas. True to the traditions of the Lone Star State, the mural on the left is 18-carat gold-plated.

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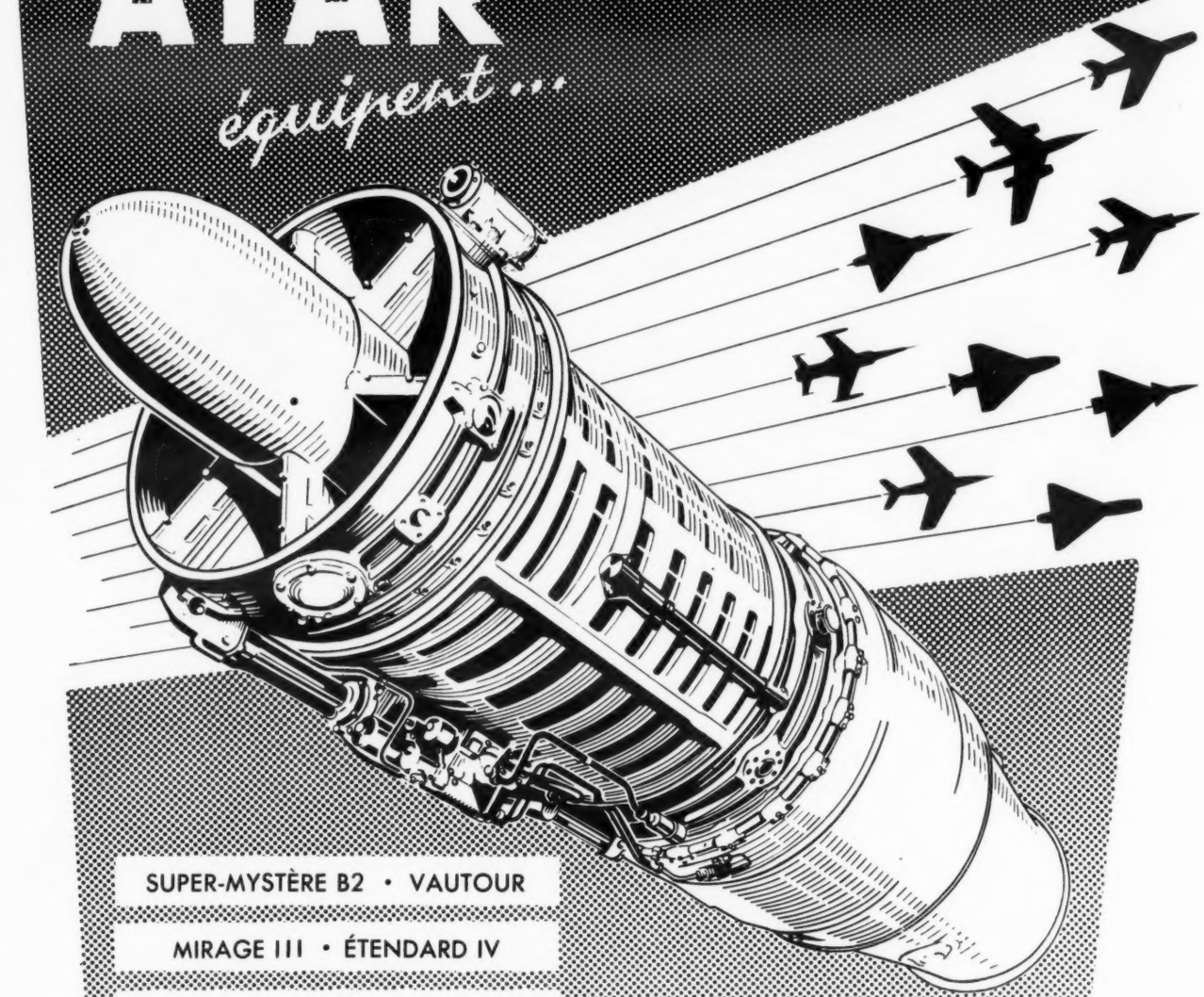

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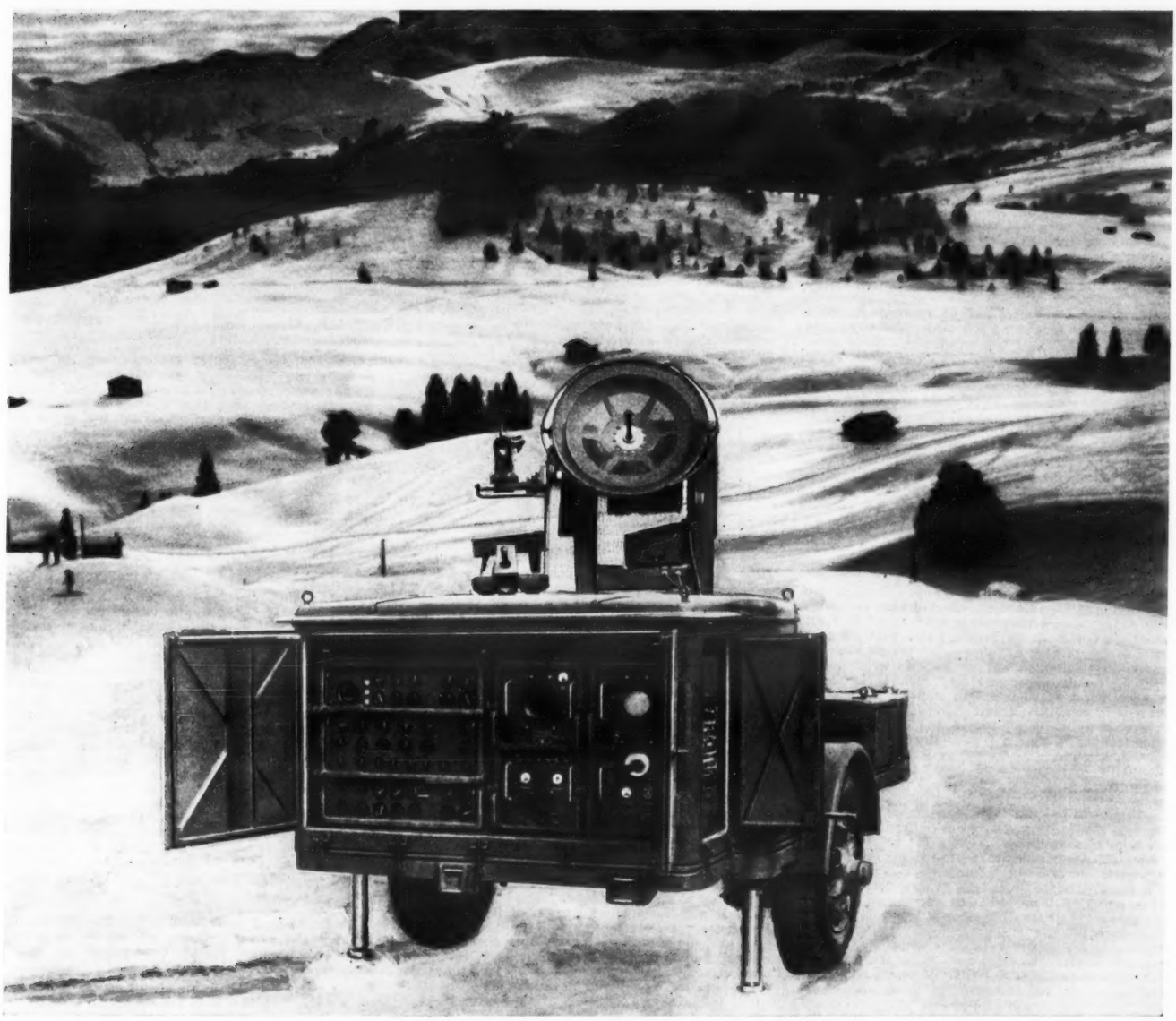

The Mind of Mr. Reader

Why undershoot?

Sir,

As an airline pilot, I think I can answer some of the points raised by Patrick Johnson in his letter about undershot landing technique (cf. *Interavia* for December 1956).

I hope he will not consider me disparaging when I say that as far as present-day *commercial* flying is concerned, the days of Gosport when aircraft had no brakes, flaps, reversible pitch propellers, and wide strong undercarriages have gone and, unless there is a radical change in aircraft design, the precept of " overshoot rather than undershoot " has gone with them.

First, to definitions. To me, undershooting on an approach means that the aircraft is placed by the pilot, by accident or design, in a position too low or too far out to make a *glide* approach to the runway from that position. The pilot must therefore use engine power to reach the touchdown point.

Further, by " glide approach "—or, as our American friends more graphically put it, " deadstick approach " —I mean that the throttles are closed, although the engines are still running.

This, I take it, is roughly what Mr. Johnson has in mind when he speaks of the undershooting condition, and I think we can say therefore that the concept of undershooting is inextricably tied to glide approaches. Would that be a syllogism ?

So now let us see what glide approaches mean in terms of present-day aircraft.

The simplest little aircraft I ever flew was a *Tiger Moth*. Throttle back, drop the nose, dive it down, then think of an altitude below, and when the altimeter is within 100 feet of it, just pull up into level flight—not forgetting to put on the power again of course. Let Mr. Johnson try that with any modern civil airliner.

After a few attempts he would find that a machine weighing up to 70 tons descending at 2,000 feet per minute or more requires far, far more than the " pull up level " space required by the old *Tiger*. Yet 2,000 feet per minute is quite normal for modern civil aircraft in the " glide " condition, due to modern aerodynamic trends, i.e. high wing loadings, etc. In fact, the particular aircraft I fly—an extremely popular one with great passenger appeal by the way—has a " power off " rate of descent with undercarriage down, landing flap, and at normal approach speed of some *4,000* feet per minute. That is some glide ! I think that were Mr. Johnson to experience a landing after such an approach he would prefer the more sedate and less violent arrival he complains of.

But of course, the main consideration is safety; in fact it is paramount in importance. Civil aircraft make approaches in very poor weather conditions, and very often the aircraft comes out of cloud at 300 feet above the ground.

On a *glide approach* that means the transition from watching the small phosphorescent instrument panel and answering its every flicker to seeing the sky and ground merging ahead, the runway lights perhaps blurred by heavy rain on the windscreen and wind gusts swinging and turning the aircraft in every direction but the right one—all this at 130 m.p.h.—with fog, drizzle, and patches of low scud thrown in for good measure—this transition must be achieved both physically and mentally by the pilot in around 6 seconds or less.

That's rather a tall order, Sir !

So what can we do instead ? We can establish a standard approach for all aircraft, which is what in fact has been done. Most civil airports have an I.L.S. (radio beam) or a G.C.A. (radar) approach aid. Both these aids establish the pilot on a " glide path " which is usually around 2½° elevation. At an average speed of 120 knots this requires a constant, controlled rate of descent of 500-600 feet per minute, thus allowing the pilot—in the type of conditions I have mentioned above—30 or 40 seconds to orientate his mind and body to make a visual landing. I think it is this " drag in " that upsets Mr. Johnson so.

As far as obstacles on the approach are concerned, Mr. Johnson need have little fear. However daunting they may seem, they are well below him. Just consider how high a 100-foot building is, for instance. The aircraft is usually that high when it crosses the airfield boundary just prior to touchdown.

National airport authorities are required by I.C.A.O to provide obstacle-clear approaches to their runways to a standard which leans very far towards the side of safety. After all, it must be remembered that each runway approach path is also the *after-take-off path* when the wind reverses, and the standards of freedom from obstruction are clearly even more demanding as they take into account the flight path of an aircraft whose after-take-off performance is affected by the worst possible conditions, i.e. undercarriage down, one engine failed, slight *tailwind* component, high ambient temperature, etc.

In actual practice, I believe, the criterion of the after-take-off path under the worst possible conditions is used in establishing obstacle clearance for all runway approaches. And, of course, runways which do not match up to these standards are just not used by civil operators.

So I think we can assume that unless the aircraft is in a rather desperate plight, the likelihood of hitting anything except the wheels on the runway is virtually nil.

Now to the 20% rule which Mr. Johnson would see established.

I hope in the last paragraphs I have been able to show why the approach to the end of the runway is basically not at all an unsafe operation—even in the worst conditions—when it is carried out in the normal, standard, disciplined manner. It would be therefore simple for me to say Q.E.D. and leave it at that, but there are a few considerations that are worth mentioning.

First, the runway is primarily regarded by the pilot as the " landing distance available ". Note that—*available*.

Secondly, as aircraft today are predominantly of the tricycle type, that fact that it has touched down does not mean that it will stop merely because it is on the ground —remember, the wings are not stalled and are thus not giving appreciable aerodynamic drag as in the tail-wheeled types. This being so, and also in view of their streamlined form, their momentum is much greater; hence, the invention of the reverse pitch propeller and more recently, the reverse thrust jet, to shorten the " roll out ".

Bearing this in mind, we come to the third point, which takes the shape of the cash register, with the airline accountant behind it. This gentleman is a big figure in aviation today, a very big figure indeed.

Reducing the landing distance available reduces the actual landing run (ask any pilot), and reducing the landing run reduces the brake linings oh, so much faster, to say nothing of tyres and of passengers' waistlines through seat belt massage.

Then last, but certainly not least, there is the pilot's view. (He, incidentally, has had it drummed into him from the day he first sat in an aeroplane " The runway is there: use it ! ").

To the pilot the short runway is an added hazard—an extra factor to take into account when all the others are doing their worst. Knock 500 yards off a runway and immediately a " reasonable " 2500 yards becomes a " shortish " 2000. I imagine it would be rather galling after experiencing brake failure on touchdown at the 20% point and, while the undercarriage was merrily collapsing below as one left the end of the runway, to realise that 500 yards or so extra might have made all the difference. I should not care to meet the person responsible for 20% after such an experience myself—or should I say that he would not care to meet me !

Make no mistake, brake failures can be dangerous in aircraft. The streamlined tricycle types mentioned before are able to, and do, move forward when the brakes are released, merely on the power supplied by four engines which are *ticking over*. How does one stop without brakes? It is interesting to wonder whether the pilots who will fly the 1960 aircraft (no names—no landing distances !) would like the 20% idea. Really, I'm all for it, as long as we first increase the overall runway distance by 25%.

By the way, Mr. Editor, I would not place too much faith in your belief that a pilot takes a psychological pride in performing a precision landing—it sounds far too clinical ! Let's say that the average Mr. Reader usually parks his car in a reasonable position without too much of a song and dance. When he has to, he can park it in a tight space perfectly, but he isn't always required to do it, and doesn't usually do it unnecessarily.

But what about the estimated 500 lives lost in the last five years through " undershooting "? I will not challenge this statement, frankly I cannot because I just do not know what the actual figures are. I tend to think they are somewhat lower. However, if only one life were lost in the whole history of flying during an approach and landing, it would merit a full inivestigation.

We should ask *why* and continue to ask *why* until the correct answer has been established, and *action has been taken to avoid a repetition.*

The all-too-usual findings of an accident enquiry result in the magic formula—" an error of judgment on the part of the captain ". " Ah ", people say, " so that was the reason for the crash ". But was it? There is an accident because a man made a mistake—but what caused *him* to make a mistake?

Surely people who have spent their lives doing one job, and concentrating particularly on one vital aspect of it just don't make mistakes if their lives (yes, lives not livelihoods) depend on it unless their mental and physical condition is unable to stand the strains and stresses exerted by external conditions.

So may I grind the pilot's personal axe?

When is a man's performance going to be judged not so much upon what he *does*, but also upon those outside influences which put him in the position where he did what he did?

I refer, of course, to weather, overloading of R/T, in flight emergencies, excessive work load due to " crew economies ", and that ever-present spectre (though rarely officially recognised)—mental and physical fatigue.

One day I hope to open *Interavia* and find one of your excellent articles dealing with this last, but vitally important subject.

London, S.W.13. DAVID UNDERWOOD.

A needle in a haystack

Sir,

As the thorough study of *Interavia* every month has now been one of my more interesting occupations for some years, I should like first to introduce myself as a loyal member of your great international readership. However, there is one question I should like to ask about the December 1956 issue.

On page 957 of the article by Dr. S. F. Singer, column 1, under the heading " Satellite orbit ", the author writes: " Its dimensions will be small, of the order of 20 inches . . . but large enough to be trackable from the ground by optical and radio techniques. Under ideal viewing conditions at dawn and dusk . . . it will then shine by reflected sunlight and appear like a faint star . . . " etc. A few pages further on, the reader is no less astonished to learn that, for the better observation of lunar satellites, use could be made of 40-ft. balloons, which would appear as stars of approximately 11th magnitude . . .

While I find it difficult to imagine how even the latter statement could be applied in practice, it seems to me quite impossible to observe an *earth satellite of about twice the size of a football*, as claimed in Dr. Singer's article, despite the fact that it would circle relatively near to the earth. How much trouble it is, for example, to spot a jet fighter against a brilliant blue sky, despite binoculars and condensation trails, and how difficult it was to my knowledge—and I am speaking of times of clear weather—to make out Professor Piccard's stratosphere balloon, which was about 130 ft. in diameter and floated at an altitude of some 52,000 ft !

Berlin. PETER RAABE.

Successful observation by telescope could, of course, be made only if the exact spot and time at which the satellite was to appear were known beforehand. Incidentally, the artificial earth satellite would be more suitable for optical observation than a lunar satellite, as the ratio between its diameter and the mean distance between the earth and the satellite would be greater than that between the lunar satellite's diameter and the mean earth-moon distance.

Editors.

" Be ye as little children . . . "

Sir,

Many thanks for your (information) stating that you cannot at present see any connection between certain aircraft accidents and the earth's movement through space.

I feel sure you made this statement because the " experts " have told you that my contention is nonsense. It has always been thus; there are many examples in history to prove that the " experts " are often the last persons to understand simple new things; for example, *none* of the physicists living at the time of Rob. Mayer grasped the law of the maintenance of energy. And they included Helmholtz ! The brewer Joule then demonstrated by mechanical means that Mayer—who had by this time thrown himself out of the window in desperation—was right. So, Mr. Editor, I feel we have not yet heard the last word. Some day *your* magazine too will have to write about connections between the earth's motion and the " relative " movements of aircraft, and not only as concerns the earth's rotation.

Nüremberg. WILHELM MICHAEL.

Reader Michael was assured in No. 11, 1956 that the influence of the earth's rotation was allowed for in long-range navigation. — Further developments are awaited with equanimity.

Editors.

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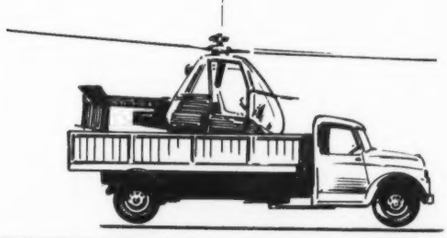

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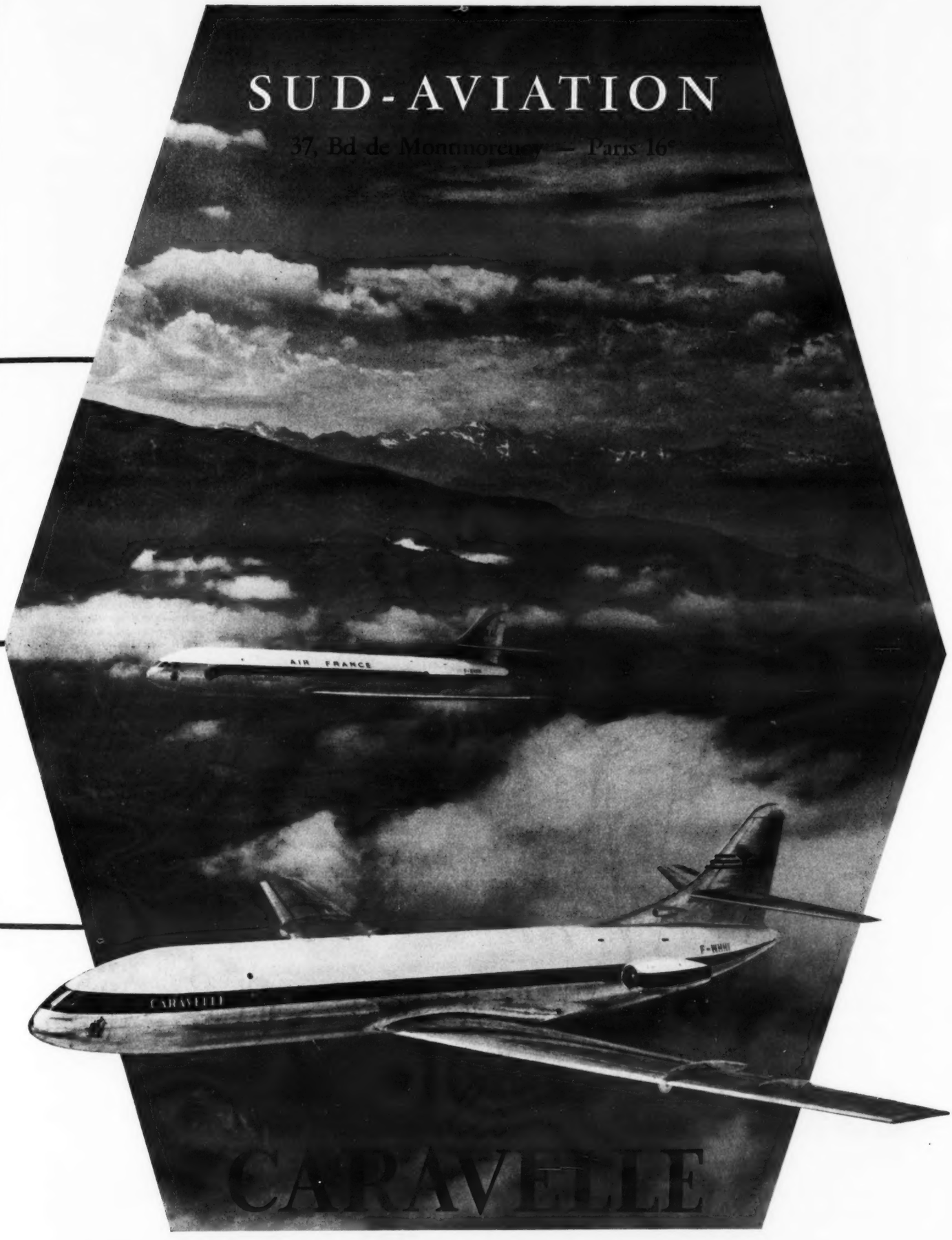

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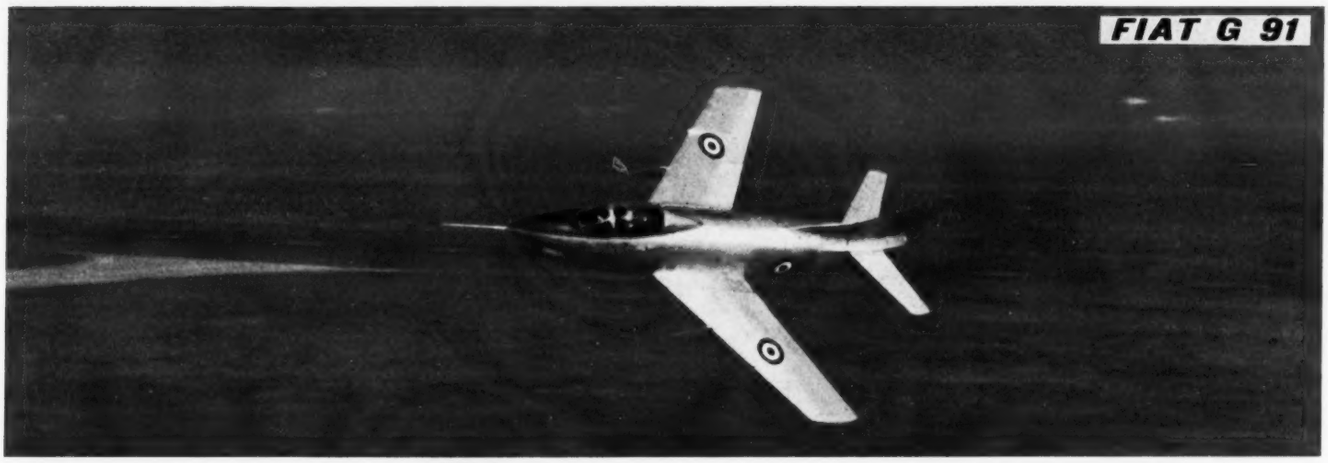

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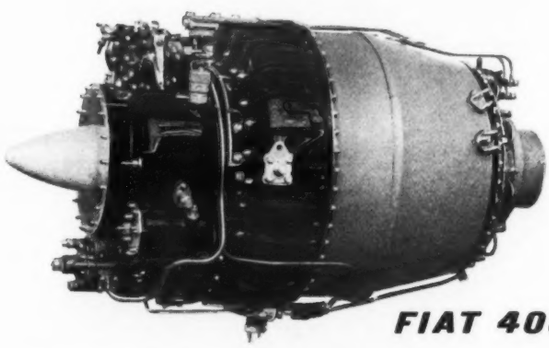

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enables you to pay for your journey in 3, 6, 9, or 12 monthly instalments. You fly today and pay tomorrow.

AIR FRANCE
always in the forefront, is preparing a future worthy of its present. In ordering 12 Caravelles and 10 Boeing 707s it is one of the first airlines to advance into the jet age

Travel agencies and AIR FRANCE are at your service to advise you and prepare for you the best possible journey

the Super G

the fastest aircraft over the longest distances is now in service on AIR FRANCE's long-range network

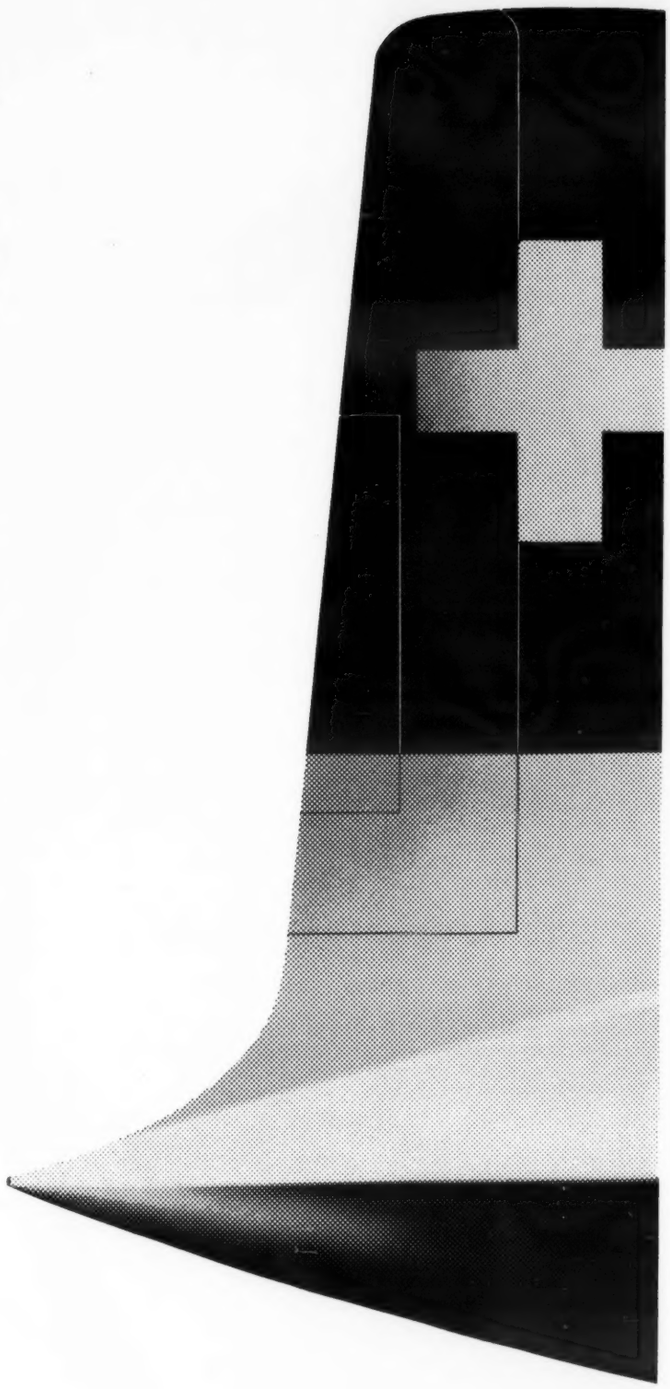
AIR FRANCE

the long-distance expert

37 years of experience and progress over the world's longest network

New Sky Trails for your Travels

Whether you're heading for the Far East, South America, or the United States, you will be pleased to know that Swissair, the Airline of Switzerland, now offers you world-famous Swiss service on these great new routes:



New to the Far East

Europe – Karachi – Bombay – Bangkok – Manila – Tokyo.
Douglas DC-6B aircraft. Sleeperseats and tourist accommodations. Service begins April 23rd.
Alternate route to Karachi – Calcutta – Bangkok – Hong Kong – Tokyo starts July 5th.

New to Argentina

Europe – Buenos Aires via Dakar, Rio de Janeiro and São Paulo.
Served by Douglas DC-6B's, beginning April 7th. Supplements our present route to Rio and São Paulo.
Sleeperseats and tourist accommodations.
Douglas DC-7C "Seven Seas", world's fastest, most modern civilian aircraft will be in service on this route from July 4th.

To the USA

Switzerland–New York via Lisbon* or via Cologne or direct } begins May 5th

Until May 4th service as in the past via Frankfurt.
Douglas DC-7C "Seven Seas" and DC-6B's.
Berths, sleeperseats, first class and tourist accommodations.

(*Subject to final government approval)

Now – all the way from New York to Tokyo . . . Tokyo to Buenos Aires – you can indulge in those tasty Swiss dishes . . . enjoy the unsurpassed Swiss hospitality and service you've appreciated on your Swissair flights in the past. All planes on these routes are equipped with RCA airborne radar.

Consult your Travel Agency for further details.

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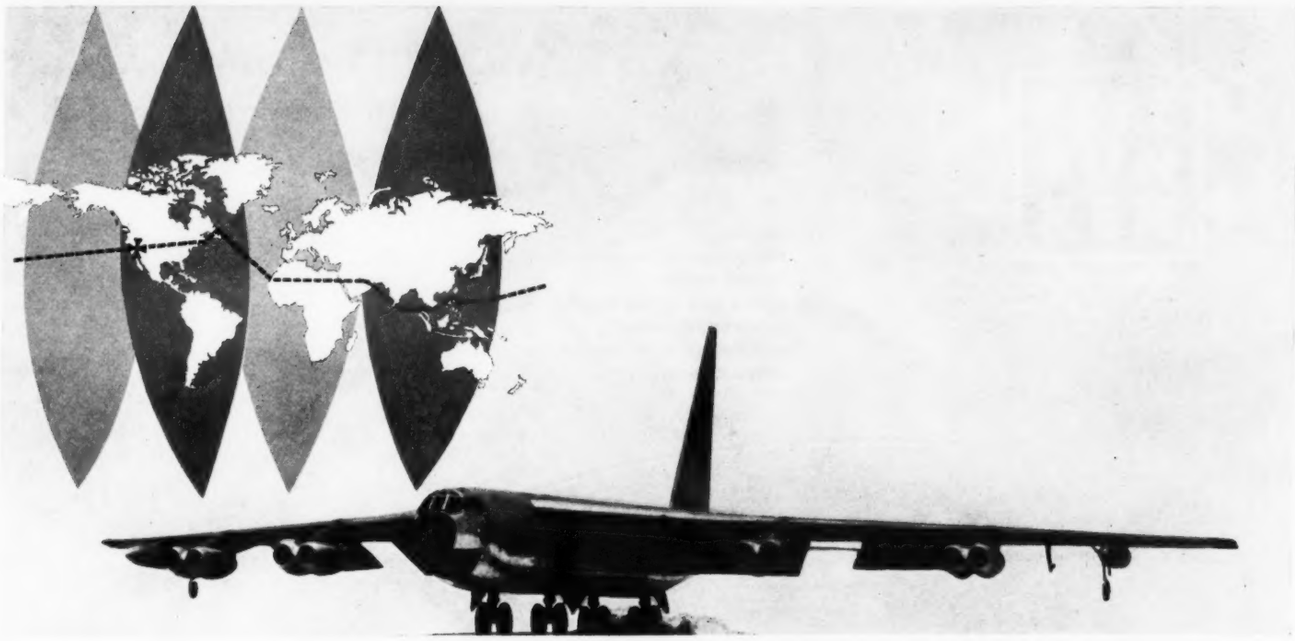
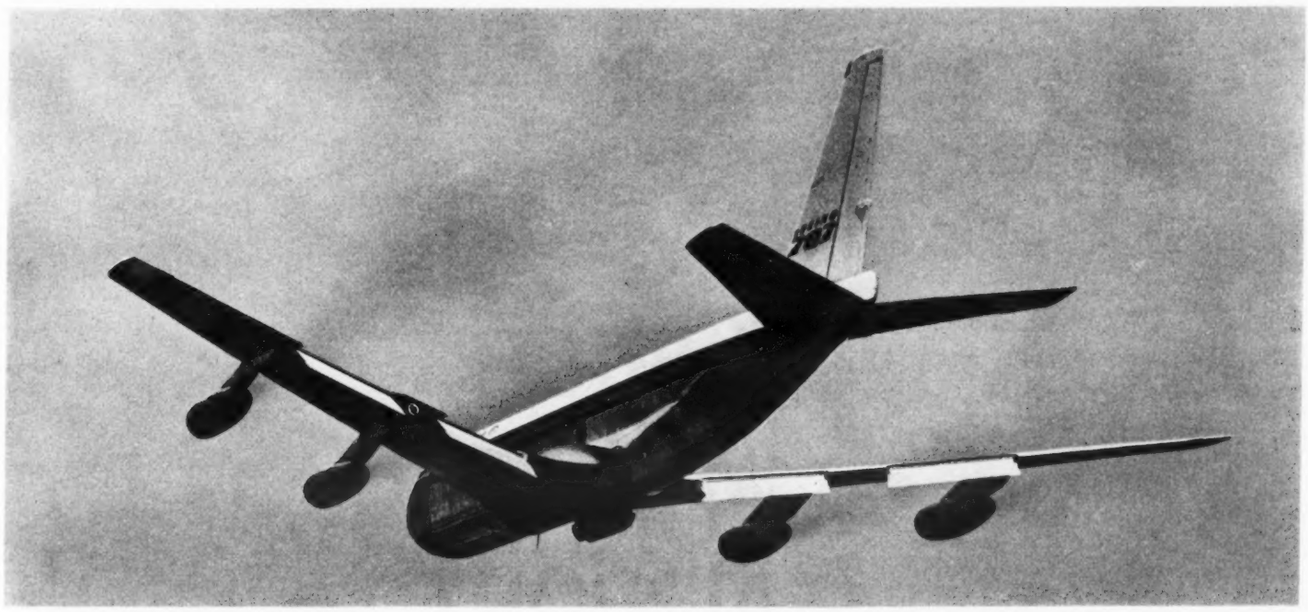
SWISSAIR



Around the world, nonstop in 45 hours, 19 minutes. U.S. Air Force makes history, flying swift, dependable B-52 Jets—by Boeing.



The Boeing 707—America's first jetliner—will bring you equally proved performance on domestic and world routes.

BOEING 707

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B.O.A.C. - BRANIFF - CONTINENTAL - LUFTHANSA
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ZURICH INTER-CONTINENTAL AIRPORT

Important connecting point in World-Wide Air-Traffic

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QUARTZ CRYSTALS
ON LAND
AT SEA
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"Decca – I wouldn't fly without it..."

... fantastically accurate—didn't believe it at first ... see exactly where you are all the time—in any sort of weather. That's the Flight Log, shows exact position all the way from Take Off to Touch Down, on the deck too for that matter—I hear they're even thinking of fitting the fire engines at L.A.P.

It's the only thing that gives you a constant check on wind ... you can get a spot-on ground speed too, makes all the difference in calculating ETAs ... much more popular with ATC—on track all the time, and arrive on the dot ... makes holding and approach procedures a piece of cake, although I don't seem to have had many delays since we fitted Decca.

Useful in emergency too—remember that Bordeaux do last year when they just made the coast on Decca ... made quite a fuss about it at the time ... seems to me with the ever increasing numbers of aircraft it would be a lot safer if everybody used Decca.

THE DECCA NAVIGATOR

THE WORLD'S MOST ACCURATE NAVIGATION SYSTEM

THE DECCA NAVIGATOR COMPANY LTD LONDON

INTERAVIA

Deadline Notes

No. 4, 1957

TWO MILLION TOURIST CLASS PASSENGERS have flown across the North Atlantic since the introduction of tourist class service on the route. A brochure entitled "Five Years of Transatlantic Airline Tourist Service" has been published by I.A.T.A., from which the following highlights are taken: Since the tourist class was introduced on May 1st, 1952, passenger volume has steadily risen, by 17% between 1952 and 1953, another 9% in 1954, 19% in 1955 and 20% in 1956. The 329,656 passengers over the route in 1951 increased to 785,000 in 1956, and there is every prospect that the figure of 1,000,000 will be reached in 1958. Since May 1st, 1952, the airlines have operated almost 83,000 flights across the North Atlantic, stepping up their average frequency from 33 a day in 1952 to about 60 per day at the moment. - The tourist passenger has, in fact, been an increasingly valuable export commodity. His average expenditure abroad, exclusive of fares, has been climbing - $767 in 1952, $812 in 1953, $839 in 1954, $891 in 1956. - For the airlines concerned the revenue situation is less rosy. The net profit of international air transport is still little more than 1%. With the introduction of tourist class services, the first class services dwindled, hitting a low of 170,000 in 1954. Then, however, this figure began to rise, to 190,000 in 1955 and to 209,000 in 1956.

NORTH ATLANTIC FARES are to be raised by 5%, by decision of member airlines of the International Air Transport Association. Sir William P. Hildred, I.A.T.A. Director-General, said in a press statement: "The Suez Canal crisis, which has brought about an increase in the price of fuel and temporarily lowered profits, is only one of the factors involved in the present situation. But it has been the deciding element." The increase comes into effect on May 1st. It was also announced that fares on European routes would be increased by a maximum of 5% from May 1st.

THE U.S. DOMESTIC AIRLINE INDUSTRY has embarked upon the task of convincing the public that pending requests to raise airline fares are long overdue. Formal requests for permission to increase fares by 6% have been submitted by Braniff Airways Inc., Capital Airlines Inc., Delta Air Lines, Inc., Eastern Air Lines Inc., Northwest Airlines Inc., United Air Lines Inc. and Trans World Airlines. The Civil Aeronautics Board has ordered a thorough investigation into the overall fares structure.

A HIGH COMMISSION FOR CIVIL AVIATION is likely to be the solution chosen for the problem of separating civil and military aviation in Italy. At present, civil aviation comes under the jurisdiction of the Ministry of Defence "Air", but a reorganization has been under discussion for some time.

SCANDINAVIAN AIRLINES SYSTEM carried more than 600 passengers on the Arctic route from Copenhagen to Tokyo during the first month (the route was inaugurated on February 24th). Roughly 75% of the passengers made a round-the-world flight, travelling via the North Pole in the one direction and returning via the southern route through India. Capacity offered was 370,000 passenger-kilometres and 225,000 freight tonne-kilometres.

SWISSAIR on March 31st completed trials with the Scottish Aviation Twin Pioneer which it had leased for a period of three months. The purpose of the trials was to study the aircraft's behaviour and technical aptitude and the possibility of commercial utilization on short-haul and feeder services where only a small space is available for take-off and landing. The results obtained will now be examined carefully, and until they are evaluated, no definite decision about purchasing Twin Pioneers will be made.

K.L.M. ROYAL DUTCH AIRLINES has placed an order with Scottish Aviation Ltd. for an undisclosed number of Twin Pioneer aircraft, according to the "Weekly News Letter" of the Society of British Aircraft Constructors.

SABENA is introducing mixed first/tourist class Douglas DC-7Cs on the Brussels-Geneva-Leopoldville-Johannesburg route on April 22nd. The longest non-stop leg, Geneva-Leopoldville, will be flown in 12 1/2 hours.

HUNTING-CLAN AIR TRANSPORT LTD. has placed an order with Douglas Aircraft Co. for two DC-6A Liftmasters for delivery in the second half of 1958. The value of the contract is approximately $3,300,000, including spare parts. Although primarily destined for Hunting-Clan cargo services from Britain and Europe to East, West and Central Africa, the aircraft will be of dual-purpose configuration, having the flexibility to carry all cargo, all passengers or variable proportions of either type of traffic depending on demand.

THE SOVIET AIRLINE AEROFLOT will open a new route between Helsinki and Leningrad on April 14th. One flight a week will be operated until June 1st, when the frequency will be stepped up to three flights a week. Aeroflot will use Ilyushin Il-12s or Il-14s.

* From INTERAVIA's world-wide news service, including INTERAVIA AIR LETTER, the daily international aviation news digest. — No part may be reproduced without written permission.

VNUKOVO AIRPORT, near Moscow, is being enlarged, according to a report from East Berlin. Both two-storey wings of the main building will be lengthened by nearly 90 ft. and so organized that international and domestic traffic can be handled separately. A new 52-room hotel for transit passengers is under construction. The runways and aprons are to be substantially enlarged in preparation for the introduction of the Tu-104 jet transport into regular service.

U.S. DEFENSE DEPARTMENT EXPENDITURES for procurement of aircraft and missiles for the first six months of fiscal 1957 (July 1st, 1956 to June 30th, 1957) totalled about $4,600,000,000, or 57% of the estimated total expenditure earmarked for them for the whole year. About $3,700,000,000 was spent by the three services for the procurement of aircraft, and slightly more than $850,000,000 was spent on missile production, compared with about $445,000,000 during the corresponding months last year. In addition, about $13,900,000,000 was obligated. Overall Defense Department expenditures on research and development showed an increase of 11% during the first half of the fiscal year, totalling $787,000,000. The total Research and Development programme for fiscal 1957 has been estimated at $5,200,000,000, including funds for activities directly supporting the research, development, test and evaluation programme.

THE U.S. ARMY is making an evaluation study of the Fairey Ultra-Light small helicopter to assess its ability to meet Army requirements for a light two-seat helicopter, according to an announcement by The Fairey Aviation Co. Ltd. In the negotiations with the U.S. Army, the British company is being represented by the Piasecki Aircraft Corporation, of Philadelphia, Pa. The latter company also holds an option to manufacture the Fairey Ultra-Light helicopter in the United States. The American designation for the machine would be Model 72.

BRISTOL AEROPLANE CO. (USA) INC. is being organized as a sales coordination and servicing company in America. The President will be Stanley Haggett, and the Chairman Air Commodore Banks.

HUNTING-CLAN AIR TRANSPORT has disposed of its two new Viscount 759 aircraft to Icelandair. The aircraft were initially ordered for the Safari Colonial coach class services, but Hunting-Clan has been unable to use them as planned.

*

WORKSHOP BRIEFS . . .

The Canadair CL-28 prototype made its first flight, lasting 75 minutes, on March 28th. * The Morane-Saulnier 1500, a two-seat single-jet communications aircraft, is mentioned for the first time in a Morane-Saulnier S.A. publication. * The Autonetics Division of North American Aviation Inc. has received contracts to a total value of $4,300,000 from the U.S. Air Force and U.S. Navy for Nadar recording systems. Nadar is an electro-mechanical magnetic tape recorder-reproducer system. * Production plans for the Dassault Super Mystère B.2 fighter provide for a monthly output of 15 aircraft by the end of 1957. The first Super Mystère B.2 squadron is expected to be set up next autumn. * CYTAC, a new long distance radio navigation system based on Loran, is announced by Sperry Gyroscope Co. Range at sea 1,900 nautical miles. * Fouga is testing an experimental version of the CM.170-R Magister with modified wing of slight dihedral. The company is also building a four-seat observation aircraft, the CM.232, for the French Army. * Development of a new jet engine for a thrust of 6,270 lbs. is announced by the newspaper "Volksarmee", official organ of the East German armed services. According to the same report, the engine is to be fitted in Industriewerk Dresden's BB-152 four-jet commercial transport. * A production SO.1221 Djinn helicopter, piloted by Jean Dabos, has set up a new altitude record of 8,482 m (absolute altitude record for all classes of helicopter). * A single-engine agricultural aircraft is under development at N.V. Holland-Air, Katwijk; designation HA-001. One 135 h.p. Lycoming 0-290-D2; single-seat. * Piaggio is developing a twin-engine P.166 executive aircraft with Lycoming GSO-480 engines (340 h.p. take-off rating). Gross weight 7,050 lbs.; payload up to 2,420 lbs.; cabin for 6 to 8 persons. * Collins Flight Directors type FD-105 (development of the 1951 Integrated Flight System) will be installed in the 21 Douglas DC-8s and 40 Lockheed Electras for Eastern Air Lines. * The Pratt & Whitney JT3C and JT4A jet engines (civil versions of the J57 and J75 respectively) have been approved by C.A.A. for air transport use. The two engines are scheduled for installation in particular in the Boeing 707 and Douglas DC-8 transports. The Atar Volant C-400 P-2 (version of the C-400 P-1 with pilot's seat) developed by France's SNECMA has begun free flight tests. * RW 3 Multiplan is the designation of a convertible aircraft built by the Rhein-Westflug group of inventors in Germany. * The Dassault Etendard VI, Breguet Taon and Fiat G.91 light-weight fighters built under the N.A.T.O. programme are shortly to undergo a period of operational testing at the hands of a group of N.A.T.O. pilots. A new version of the SE. Baroudeur will also be evaluated. * Douglas Model 1906A is the type designation of a new assault transport designed for use aboard carriers or on unimproved airfields. Details have recently been submitted to the U.S. Navy. The design is laid out for four Lycoming T-55 turboprops and would have a max. payload of roughly 15,000 lbs. * Six Chance Vought F8U-1 Crusader supersonic fighters have completed a two-months' fleet indoctrination programme at the Naval Air Test Center, Patuxent River, Maryland, and have thus ushered in deliveries of these aircraft to the U.S. Navy units.

* * *

Now adopted by the Royal Air Force

JET
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(Powered by one Armstrong Siddeley Viper Turbo-jet)

Following the success of evaluation trials carried out during the last 18 months, the Royal Air Force is to become the first Air Force in the world to use jet aircraft for ab initio / basic training.

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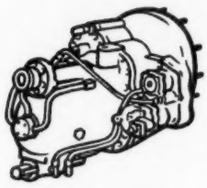
first to get off the ground in jet transports —

LEAR TRANSISTORIZED AUTOPILOTS

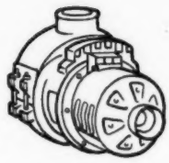
AT THE VERY DAWN of the jet transport age, Lear automatic flight controls are already in the air guiding Air France's Caravelle jet transports on route indoctrination air freight runs. And when the Caravelle enters regularly scheduled passenger services next year, an all-transistorized airliner autopilot, the Lear L-17, will be at the controls. This will be the first all-transistorized autopilot in airline use.

And for the United States Air Force, a Lear L-10 autopilot in the Boeing KC-135 jet transport tanker will provide the rock-steady sureness of flight required for the most exacting of all aerial maneuvers: air-to-air refueling of a bomber at jet speeds. In automatic flight controls for the new military and airline jets, Lear is again first in concept, first in production... to meet tomorrow's precision needs of aviation today. LEAR INC., GRAND RAPIDS, MICHIGAN IP-11

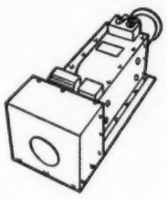
JET AGE ELECTRICS



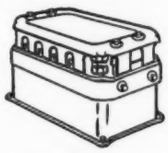
CONSTANT SPEED DRIVES



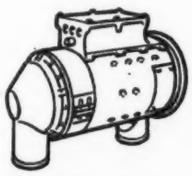
ALTERNATORS



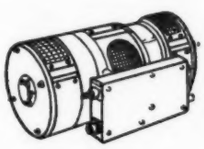
T. R. UNITS



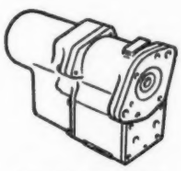
CIRCUIT BREAKERS



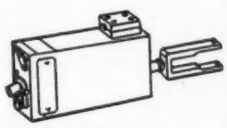
STARTER GENERATORS



INVERTORS



ROTARY ACTUATORS



LINEAR ACTUATORS

Many thousands of flying hours have been logged by modern jet-aircraft using electrical equipment designed and made by The English Electric Company's Aircraft Equipment Division for both D.C. and A.C. Aircraft Electrical Systems. New items, ranging from additional models to complete new 'families', are steadily being added to the range. Perhaps the most important new development is the ENGLISH ELECTRIC Sundstrand Drive—making practicable a Constant Frequency A.C. Power System, with full paralleling of Alternators, on multi-engined aircraft—piston or jet. Aircraft designers can now take full advantage of the many desirable features of Constant Frequency A.C. Systems, including substantial reductions in all-up weight of aircraft and increased efficiency and reliability—particularly at high altitudes.

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Every medium-haul airline in the world is faced with an urgent decision: how, and how soon, to convert to turbo-props in the 3,000-4,000 e.h.p. range.

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Few structural alterations. Installation of ELANDS in the Convair 340 has meant remarkably few modifications—and these have taken place ahead of the main engine bulkhead frame, which has otherwise been retained unaltered from the original installation. Other alterations have been confined to the instrument panel, the control quadrant, and the aircraft electrical system (adapted to include a circuit for Napier 'Spraymat' electrical de-icing of engine intake, propellers and spinners).

Three examples of successful Napier Eland conversions: the Convair 340, the Elizabethan, the Varsity.

The profit of ELAND operation—From studies made of the published direct operating costs (including depreciation) of a number of typical airlines, it is proved that in the light of our guarantees a converted aircraft will be cheaper to operate—whether the costs are calculated on the basis of aircraft miles, ton miles or passenger miles. Such calculations, of course, take no account of the increased revenue which will be earned by this, as by all other turbine-engined aircraft thanks to greater passenger appeal.

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Eland conversion means increased profits to the progressive airline

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3M COATING is sprayed on the leading edge of an airplane wing to protect the metal against corrosion. Such coatings resist water, oils, aromatic fuels, fumes and spillage of many corrosive chemicals. 3M Coatings can add to the service life of a part, cut maintenance costs, protect against abrasion and shock.

3M SEALER is used to completely seal an airplane fuel tank. This 3M Sealer remains flexible at extreme temperatures, won't shrink, and resists aliphatic and aromatic fuels. 3M Sealers can fill the pores, plug the holes or seal the joints of a unit so that liquids and gases cannot pass from one area to another.

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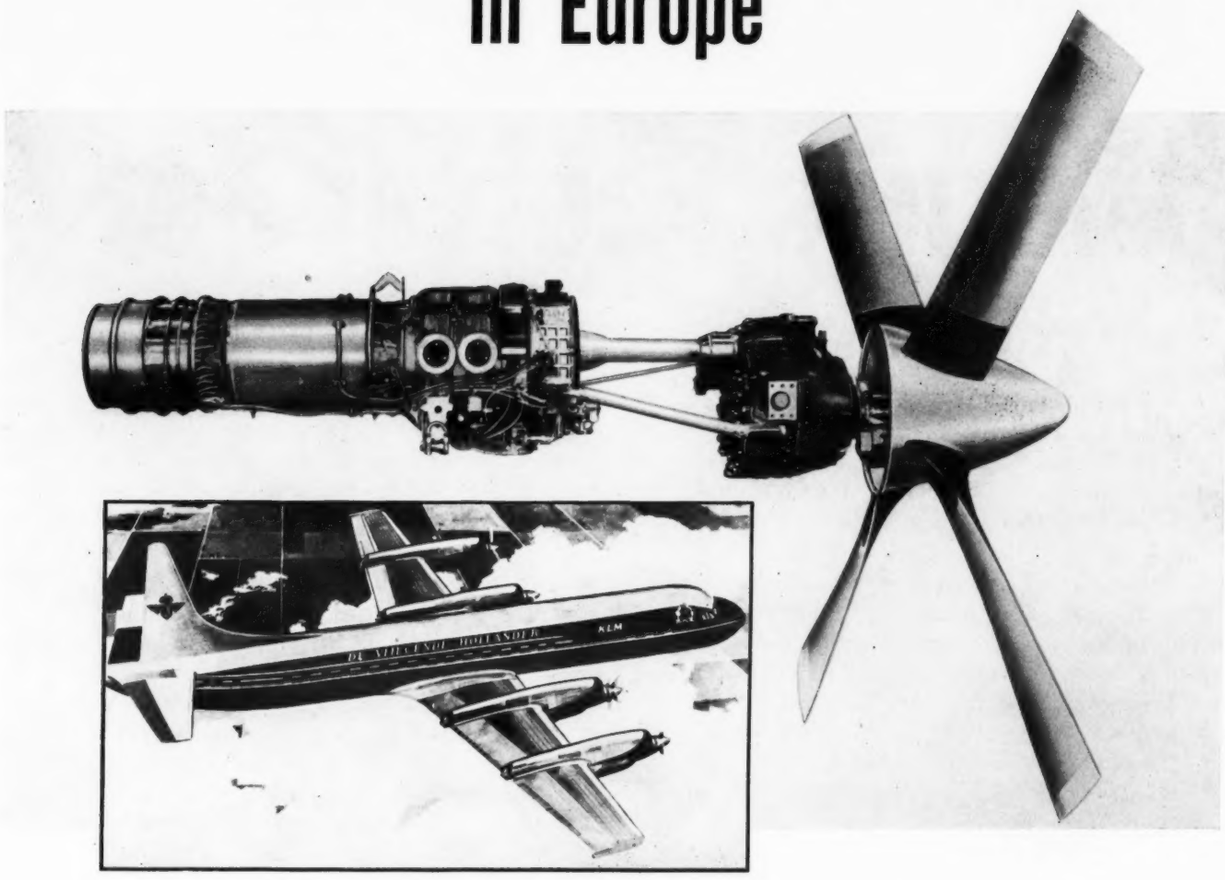
New Air Transport for the Jet Age in Europe



Lockheed Electra with Allison Prop-Jet Engines to serve on short to medium Continental routes

The jet age of air transportation in Europe will find a new type of aircraft in the sky—developed and produced by two American firms with a proven record of aviation accomplishment. This is the Electra Prop-Jet airliner, a product of the Lockheed Aircraft Corporation, and powered by four "501" Prop-Jet engines produced by the Allison Division of General Motors.

Already ordered by KLM Royal Dutch Airlines, other European airlines are finding this combination of jet engine plus propeller has advantages unmatched by any other type of turbine-powered airplane so far presented. This also has been recognized by five leading U. S. airlines who have placed orders for the Allison-powered Electra.

The Electra will offer jet age performance to air service on short to medium hops between principal cities on the Continent. It will bring speed and vibration-free comfort to travellers over these routes which jet transports cannot serve economically.

Power for these new prop-jet transports is supplied by Allison, a division of General Motors—an organization known world-wide for the quality and performance of its products.

In addition, the Allison "501" prop-jet is backed by more than 9,000,000 hours of turbine engine flight time. Mighty jet engines made by Allison for years have served the military air forces of many countries of Europe under the Mutual Defense Assistance Program. Thus not a stranger to European aviation, but a proven name in air power, Allison again has joined with Lockheed to give European air travellers jet age transportation over routes not now scheduled to be served by the larger long range jet transports.

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The **Starfighter's** dart-like configuration, perfected by extensive wind-tunnel tests, permits the F-104 to flash through the sonic-barrier, routinely, without a tremor. And even at supersonic speeds the **Starfighter** has unmatched ease and decisiveness of control — because never before have so many advanced design and engineering features been so superbly combined in one aircraft.

Like all Lockheed-built planes, the F-104 has inherent "design flexibility" that makes it readily adaptable to a variety of military requirements — at a substantially lower cost to the purchaser.

Lockheed's leadership in the design and production of military airplanes, of nine widely different types, is again demonstrated by the F-104 **Starfighter** — Lockheeds "Missile With A Man In It".

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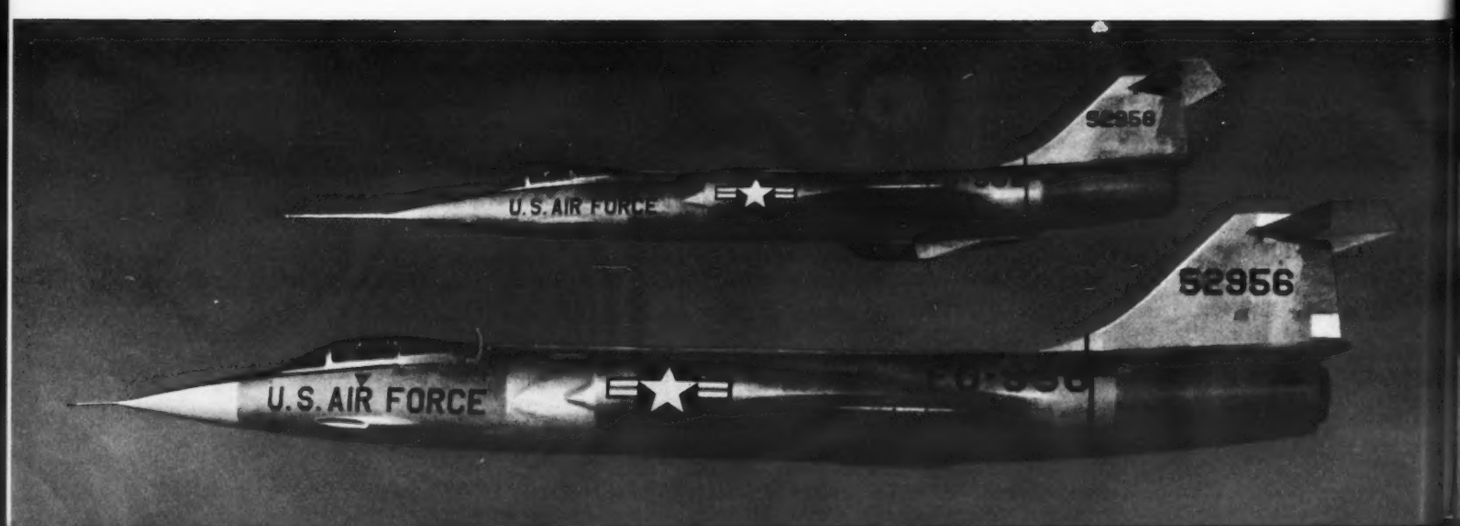

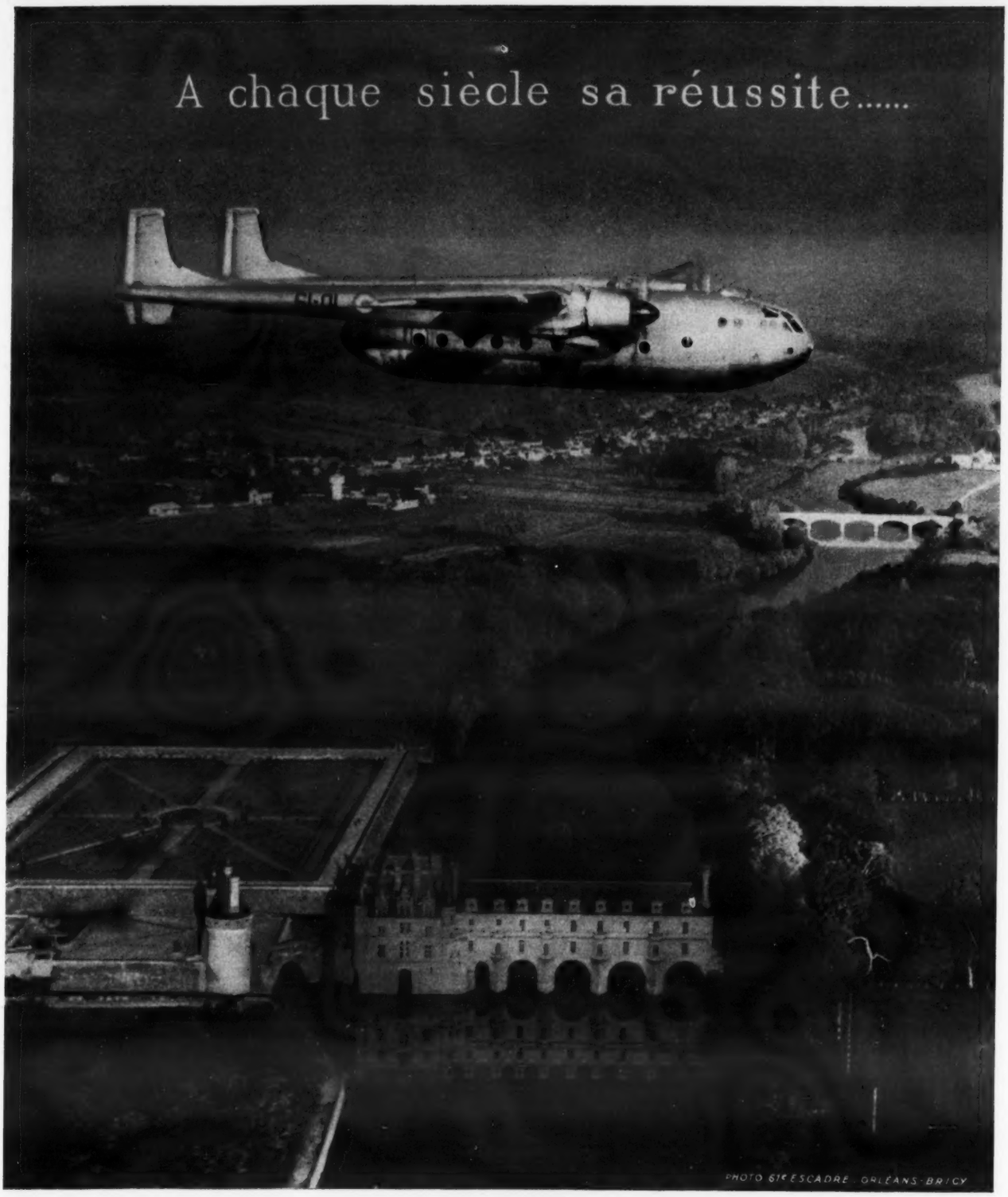

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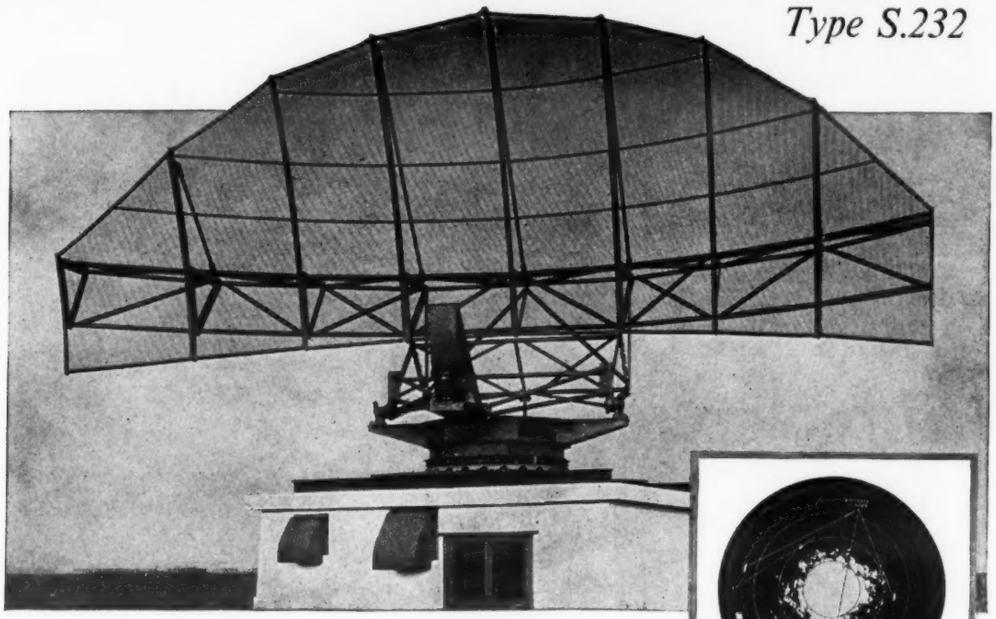
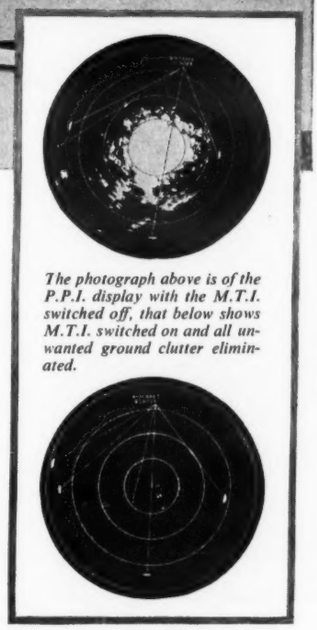
Marconi Airfield Control Radar

Type S.232





The photograph above is of the P.P.I. display with the M.T.I. switched off, that below shows M.T.I. switched on and all unwanted ground clutter eliminated.

OPERATES AT FULL EFFICIENCY IN ALL WEATHERS

The S.232 operates in the 50 cm. band using a wavelength which is long enough to be unaffected by cloud and rain. This also gives more efficient radiation from the aerial system, thus longer ranges can be achieved for the same power output and aerial gain than with short wave lengths.

CUTS OUT 'PERMANENT ECHOES' FROM MOUNTAINS, BUILDINGS, ETC., WHICH OBSCURE AIRCRAFT RESPONSE

Unwanted ground clutter can be eliminated in the S.232 by an extremely efficient Moving Target Indicator (M.T.I.) system which feeds only echoes from moving objects to the display.

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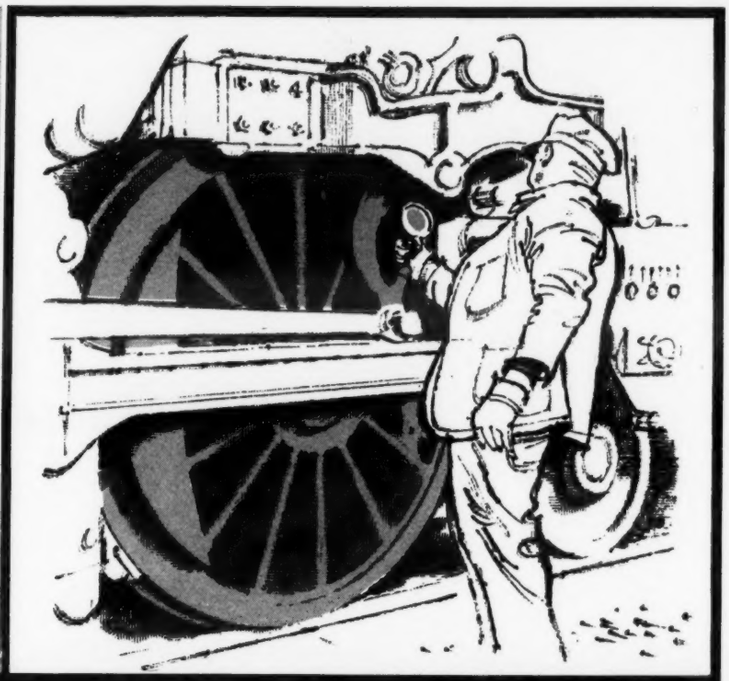

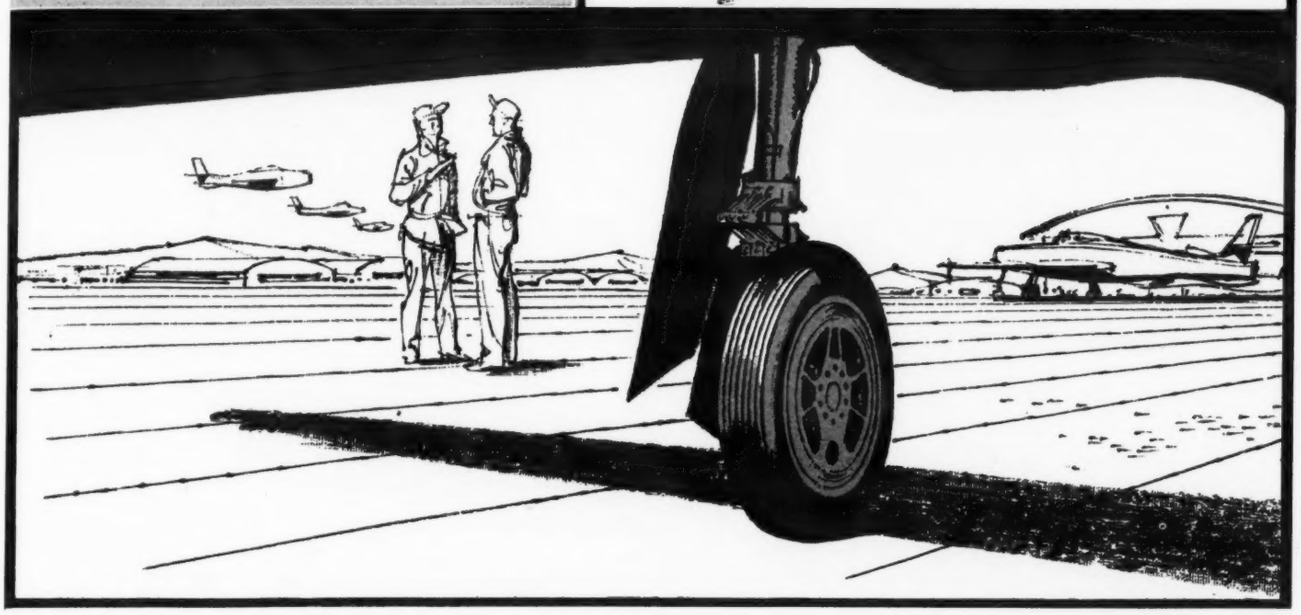

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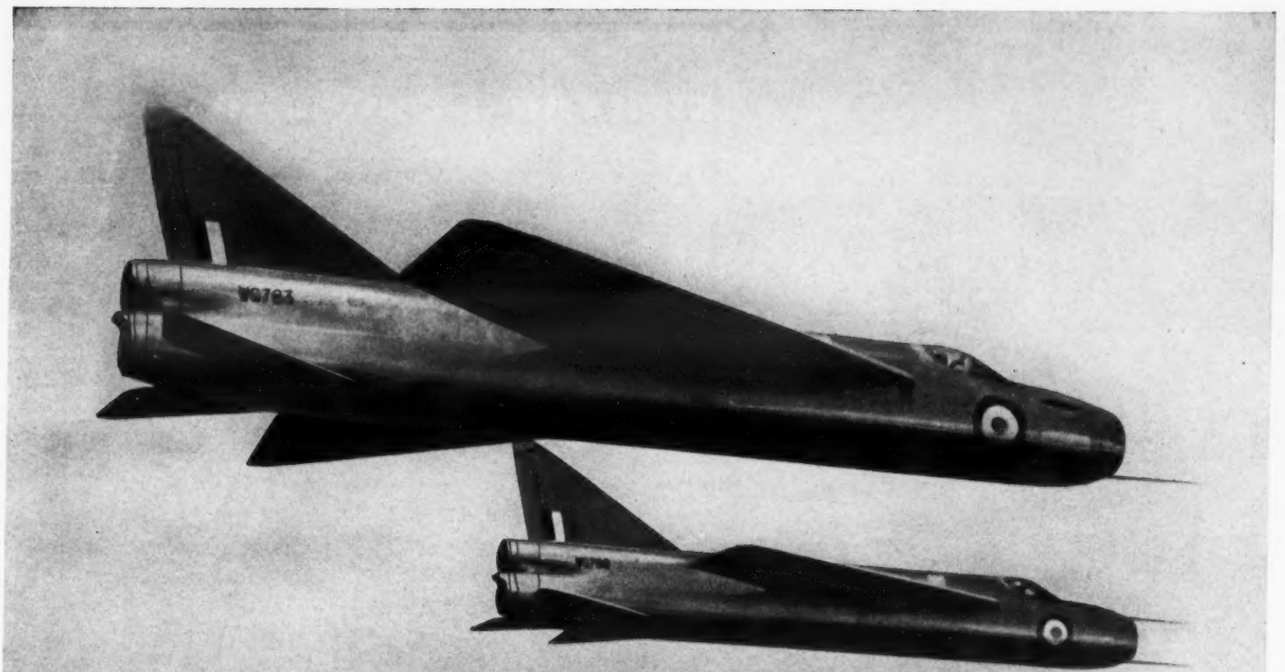

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There Is No Need for Panic About the Jet Transport Age

By Sir William P. Hildred, C.B., O.B.E.
Director General, International Air Transport Association, Montreal

A year ago, I remarked in the foreword to an I.A.T.A. Bulletin that "air transport moves from crisis to crisis and from urgent problem to urgent problem. That has been the postwar history of the industry . . . It also constitutes as accurate a forecast as one can make of the probable future." It comes to my mind now because the Institut de Transport Aérien recently quoted it as an apt comment; but I think I can improve on it.

To describe accurately the present juncture in air transport affairs, I should say that we are experiencing a concatenation of crises . . . that it is not so much a matter of problems following upon each other in an orderly series, but that because of the dynamic age we live in, they are crowding about our ears in a disorderly torrent.

These are problems of growth; they are economic, technical, and political. They arise on a world-wide scale, both as regional matters and as national questions. They appear in every possible permutation and combination. Looked at in the mass, they look formidable indeed; and they have perhaps created a certain amount of unnecessary panic.

Since we are now midway through the I.A.T.A. year, and on the eve of the 1957 meeting of the European Civil Aviation Conference, it might be well to recapitulate these problems.

They stem, mainly, from the planned introduction of jet aircraft into service on many world routes in the next three years. They also arise in part from the normal growth of civil aviation since the end of the last World War.

An industry whose activity has increased seven-fold in a decade and which has strained its financial resources to keep up with its growth, is suddenly faced with a technological revolution of tremendous proportions. A new type of propulsion will virtually double speeds and halve flying times. The optimum size of jet powered aircraft, and their potential higher utilization, means radically increased carrying capacities and must lead the airlines even deeper into their own concept and objective of mass transportation for the world.

These new aircraft are extremely costly. They require capital investment of a magnitude to which even the largest companies have hardly been accustomed. The cost of putting competitive equipment on a route in the jet era will be more than ten times what it was in 1947.

Whilst the specification sheets of the new jet aircraft promise operating economies of the sort which will make possible the lower fare structures needed to fill them, there is no absolute assurance that the other factors necessary to optimum economy will be attainable. Jets will require many changes and improvements to aerodromes, ground and navigation aids which are already well taxed by the normal traffic of piston-engine aircraft in many areas. Ground handling times, particularly time spent in customs and immigration clearances will be critical, for each non-productive minute on the ground will cost the airline more.

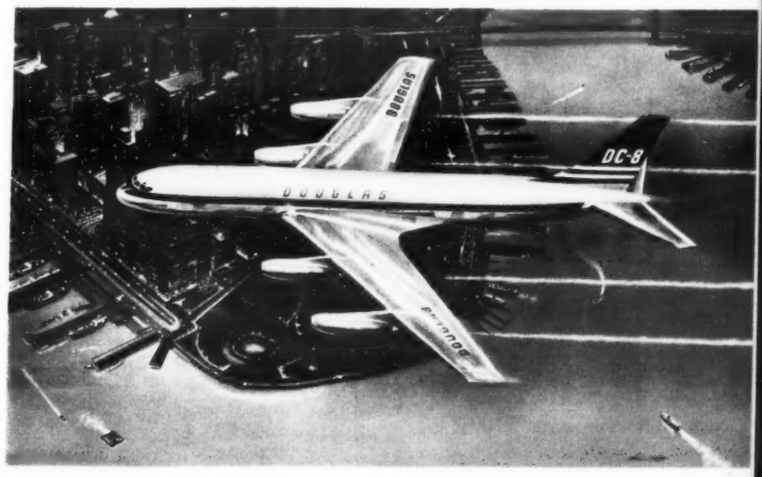
For these changes and improvements, the airlines must look to governments who are responsible for the infrastructure of civil aviation. And the civil aviation departments, whose terminals are already in many cases bursting at the seams and who are hard pressed to implement the needs of current operations, must begin to think in terms of vastly increased traffic, longer runways and other aerodrome improvements, new systems of air traffic control, better upper air weather forecasting and the like. On every one of these items there is a price tag.

All of these problems are pressing, but their solutions are well worth fighting for. Under any circumstances, they would be an immense challenge and stimulus for everyone involved. Coming as they do, however, at the end of a decade in which airlines and governments have been hard-pressed to keep pace with the astonishing world demand for air transport service, they have hit many an interested party with the impact of the straw that broke the camel's back. As a result, the reactions to these new demands have, in at least some cases, taken rather exaggerated forms.

One type of exaggerated reaction results from fear of the massive capacities of the jets. It takes two widely divergent forms. On the one hand, it results in the belief that to fill the gaping maws of its jetliners, the airline must be utterly ruthless in competing for every available passenger everywhere. On the other hand, it gives rise to the desire to put political limitations on other airlines' frequencies and capacities.

Either of these attitudes is like a drug which, helpful in a certain dosage, is deadly when taken to excess. Certainly, both together would be bad medicine and kill air transport entirely. Competition is vital to this industry and to the continuous improvement of its service to the public. But enterprises which, in every country but their own, operate on the sufferance of local authorities, must accept some restraints—all the better when self-imposed. At the same time, any attempt to put arbitrary political limitations on frequency and capacity must only invite reprisal and will in the end be self-defeating.

1960: A Douglas DC-8 jet airliner over Manhattan.



This is by no means a new problem. It was faced at Chicago 13 years ago, and after an uncomfortable hiatus the nations agreed on the system of bilateral agreements supplemented by the I.A.T.A. Traffic Conferences. Their decision was based on the belief that air transport is a dynamic activity and the hope that there would be traffic enough for all. Both belief and hope have certainly been justified during the past decade and there is every reason to consider that air transport is entering an even more dynamic phase now.

There will be conflicts of interest in the new era of air transport just as there have been in the past, but I am certain that they will be resolved as they have been in the past. We have in the Traffic Conference machinery of I.A.T.A., and in the experience of tolerance and good sense which underlies it, an increasingly effective method of achieving a *modus vivendi* in which all carriers, large and small, can thrive. It has met the test of all of the vicissitudes of the last decade and is fully capable of meeting any foreseeable future challenge.

Another area of undue consternation and alarm has been that of aerodrome, ground aids and air traffic control requirements. Looked at in bulk, they are indeed quite imposing. To civil aviation directorates these requirements must loom like the highest peak of Everest before a climber who has exhausted his oxygen supply. Yet in proper perspective and with the details sorted out and put in order, they are not so great as to cause anyone to despair.

There has, for example, been much concern about runway requirements; and I am certain that some governments have nightmares in which their national territory is entirely obliterated, and their treasuries entirely consumed by 10,000 foot runways. Whilst it is true that the 100-passenger jet taking off, fully loaded, for long intercontinental flights will eat up a good deal of runway, the operational fact—and this is the important one—is that under many other circumstances, jets will not be operated to their maximum all-up weight. As a consequence, many runways now existing are quite adequate for jets as they are, and many others require only a moderate amount of extension or adaptation.

It is impossible, as well as unwise, to cry down the gravity of the need for improved air traffic control arrangements. Yet it would be wrong to charge the requirement entirely to the jets, for much of that need exists today and it will become just that bit more critical as each year sees the inexorable increase in world airline traffic. In other words, much of the projected need is actually retroactive.

This is, perhaps, cold comfort to the civil aviation authority which is faced with a massive demand for improvement and extension of such facilities, coming on the heels of all that has been required and supplied during ten years of very substantial expansion. Yet here again the fact is that it now is possible for the first time to forecast an end to this spiral of requirements, roughly from 1959 to 1963. After that date, however, it seems entirely reasonable to expect a period of relative stability in which there will be no revolutionary developments in the art for another 10 to 15 years. Thus, we are not concerned this time with merely another upward step in an arduous and continuing climb, rather with attaining a plateau on which we can travel smoothly for almost a generation, to the benefit of all the people who want to see where other people live.

To the extent that all these problems are troublesome because of their technical complexity, both governments and airlines are fortunate in the fact that there exists an unparallelled structure of international collaboration to deal with them. The business of analysing the requirements of the jets, of finding the answers and recommending ways to implement them is in good hands. I have the greatest possible confidence in such bodies as the I.C.A.O. Jet Panel and the I.A.T.A. Turbine Operations Panel, in which the best brains and expertise of civil aviation have been brought together for just this purpose. And I feel certain that when they have completed their work of sorting out requirements, putting them in order and perspective, the task ahead will not seem as overwhelming as at first sight.

The crucial question, of course, is implementation—or more simply, "who pays"? I don't pretend to know what the total bill will be for the ideal infrastructure of 1963. I expect that it will be an imposing figure and I would not blame any civil aviation directorate which threw up its hands and said, in effect, "if the airlines want all this, let them pay for it". I would sympathize—but I would also say they were wrong.

First, I should like to reiterate a point which I made in my last annual report. Air transport is not a purely commercial enterprise. It has a very large inherent ingredient of public service and utility to the whole of society. The benefits to mankind which will accrue from this further forward step in the development of air transport will be very considerable in terms of closer relations between nations and greater possibilities for the profitable exchange of travellers, goods and ideas. Governments and communities have a vital stake in the result and an equally vital role to play in preparing for it. They must therefore expect to act as partners with the airlines in this new venture and undertake a proportional responsibility for bringing it to success.

Having taken on the burden of financing several billions of dollars' worth of new equipment, the airlines are by no means evading their responsibility for facilities. They are already paying a substantial part of the facilities bill—more than 75 percent of airport maintenance and operating costs and a very considerable percentage of the cost of air navigation facilities. Five cents of every operating dollar spent by the airlines goes into these payments, and on some routes the figure goes as high as 15 cents.

There is also the matter of ability to pay. The economic balance of the international air transport industry is like a man standing on one leg. International operations are showing a net operating profit of only 1.1 percent. The airlines' costs have been rising steadily for a decade. In undertaking their large commitments for new fleets, they are going on the assumption that this new equipment will enable them to charge less, rather than more, and thus extend their usefulness to the public. They have no fat today, and there is no prospect that they will be accumulating any for many years to come.

This is hardly a situation of their own choosing, for the airlines are not masters of their own house and their own incomes. They have so little control over their own revenue structure that they were forced five years ago to take a substantial cut in their postal revenues for carriage of the foreign air mail, and they face another onslaught on these revenues by the Ottawa Congress of the Universal Postal Union this year. This, however, is a fleabite compared to the drastic dose of passenger fare reduction which has been urged on them by many governments in the interest of promoting international tourism. In a few weeks we shall be celebrating the fifth anniversary of the institution of international air tourist fares. In terms of passengers carried, these low promotional fares have been a huge success. In terms of foreign exchange pumped into national economies they have been a significant factor in the economic recovery of the world. But in terms of profits, of reserves for re-equipment or return to shareholders they have meant very little indeed to the airlines who provide the service.

I have used the word perspective before in this article. I should like to reiterate it in urging that governments look at the whole picture in perspective before arbitrarily assessing the cost of preparing for the jet age. Air transport is a benefit to the whole national community, and the scale of benefits has risen very sharply in the last decade. The value to a country of a flourishing international aviation industry cannot be measured in dollars and cents on the balance sheet of a single government department. Airlines are already bearing a substantial part of the burden and have foregone profits in order to serve the best interest of the whole body politic. It would be a pity if, in a moment of panic, governments were to impose new charges which would jeopardize the far greater benefits they derive from the services of air transport.

Sir William P. Hildred, C.B., O.B.E.

Future Airport Requirements

By James T. Pyle,

Administrator of Civil Aeronautics, U. S. Department of Commerce, Washington, D. C.

James T. Pyle, a veteran of 25 years in aviation, was appointed Administrator of the U.S. Civil Aeronautics Administration by President Eisenhower on December 20th, 1956, in succession to the late Charles Lowen. A graduate of Princeton University, he started his career as a commercial pilot with Pan American Airways in 1935 and today still keeps his instrument rating. During World War II he served with Naval Air Transport service squadrons in the Pacific. After the war he rejoined P.A.A., rose to the post of Assistant to one of the Vice-Presidents but left in 1946 to become President of Air Charter Company, of Denver, Colo. *Editors*

It isn't easy to look ahead in aviation and make plans that will stand up under the phenomenal growth that continues year after year. It is particularly hard at this time to be accurately foresighted in planning airports. Not alone the expected growth, but several possible major changes in the nature of the aircraft that will use our airports must guide our planning.

First, our method of planning must be right, and we have developed a method of which we are quite proud, because we have a good record of prediction. The CAA operates a planning group which keeps a finger on as many sources of statistics as possible, to get the pulse and promise of the future.

This group, in its latest forecast, tells us to expect 66 million passengers on our domestic airlines in 1960; 93 million in 1965; and 118 million in 1970. These forecasts compare with our 1956 figure of about 42 million passengers. Cargo and mail figures are similarly larger in these forecasts, and that means clearly that we can anticipate some crowded airports.

How will they be crowded? First, we know that new transport planes will be larger, that they will empty 125 to 160 passengers at a time into a terminal building, all of them probably demanding their baggage at once and wanting taxicabs immediately. Departure loads of similar size will be thronging the ticket counters. As they move on the ramps, into the building, into various parts of the building and out of it on the way to the city, their "flow" must be expedited. Largely, this is a passenger-handling problem for the airlines, but the buildings must be designed properly, and that brings the CAA into the picture. We must be able to give good guidance to local sponsors whom we help with federal funds in airport construction and improvement.

These airplanes will operate differently. Jet-powered transports will hand us problems as they ply the airways, enter the airport control zone, land, taxi and come to rest on the apron. Their speed, their landing and takeoff characteristics, the noise they make and their handling on the ground are going to affect airport design, size, paving and ground handling methods.

Without a continuing effort, the airport will become a bottleneck in air transportation. Through the wise recognition by the U.S. President and Congress of the serious need in airways facilities and air traffic control, we are now embarked on a program of modernization and extension of our airways. Through added facilities and personnel, we hope to keep up with the tremendous growth in traffic, and to prepare for the growth we know is coming, particularly in the field of jet-powered air transportation. The appropriations for these purposes made last year or requested for next year total more than half a billion dollars, and in the future are certain to be extended beyond that with still more millions invested in the greatest airway system in the world. We are planning better air traffic control and more of it, reaching into the upper altitudes where the new planes will fly. We are preparing to keep flying safe in skies that will be ever more crowded.

A modern U. S. airport—Amon Carter Field, Fort Worth, Texas. Note the "fingers" in right foreground and background (Photo by John A. Stryker).

But when these planes come in to land, another set of serious problems appears. Even today, some airports cannot accept all the traffic which the airlines present at their runway portals. It would be wonderful if airline scheduling could smooth out arrivals and departures and avoid the peak hours that plague airport operators and air traffic controllers. But we must still recognize public demand for competitive scheduling on the part of the airlines that results in crowded hours, and we must still plan for bad weather that decreases airport capacity.

It used to be that a bigger airport was the answer. Now, at some cities, only another airport can handle the expected increase. There are, of course, other ways to increase airport capacity. One is the installation of parallel runways, and this is being done in some cases. The rather simple matter of quickly getting an airplane off the runway after it has landed

will enable an airport to increase its acceptance rate. We must clear runways faster. The CAA is establishing standards for faster turnoff angles, and while not many such projects are in this year's program, I am sure they will feature the programs of the next several years.

The jet brings other problems at airports. It is not true that all major airports will have to lengthen their runways or strengthen their paving. This will be necessary at some airports, but we cannot say now, specifically, which ones. There are two reasons for this: the route structure on which jets will be used still is not definitely known, and the performance characteristics of the planes have not yet been finally determined. This delays our planning. We do not know on exactly what airports jets will go into service, nor the distances they intend to fly from those airports. We do not have firm figures on takeoff and landing distances of the new planes under varying load and weather conditions. We do not know the rules under which the Civil Aeronautics Board will allow operation of these new planes. All of this requires very complicated advance figuring, and I can tell you the airlines and the manufacturers are hard at it, and we are working in very close touch with them.

Our experience with other new, larger and faster planes in the past gives us a very good basis for intelligent planning, however. Certainly the cities that produce big volumes of air travel will see the jets first, because all lines will put their best equipment on their busiest routes. And in general, the heavy traffic-producing cities already have airports with runways that will be long enough for jet flights except those of transcontinental or transoceanic scope.

Actually, we are not too concerned either about the length of runways at most potential jet terminals, nor about the strength of the runways. With dual tandem landing wheels supporting new planes weighing up to 300,000 pounds, most of our present runways are adequate, because this conformation spreads the weight over more of the pavement. There are such problems here as repetition of the weight on a given pavement segment as the dual wheels roll, and the weights experienced on taxiways and aprons and on the warmup pads at runway ends. All of this has prompted a complete national study now being made by the CAA Office of Airports of the runway strength situation.

The Dark Continent is also getting ready for the jet age. Leopoldville, Belgian Congo, will have an airport featuring one of the world's longest civil runways – 15,400 ft. (4,700 m).

One all-important fact of the coming jet planes is that we have just enough time to prepare, but none to spare. Commercial jet service is scheduled for 1959, and neither airports nor electronic gear are built overnight, nor are thousands of new technical personnel found and trained in a hurry.

Our own preparations have been in progress for several years. CAA aeronautical engineers went to England when the first jet transport appeared. CAA pilots and administrative officials have taken courses in jet operation at U.S. Air Force centers, and we now have acquired jet planes to begin our own training program. Our airport engineers are in continuous touch with jet manufacturers and operators. Even the author has flown the Boeing 707 in typical air traffic situations.

I can tell you, after a couple of sessions at the controls, that the huge plane handles easily. In a typical airport traffic situation, it can be slowed down and fitted comfortably into the pattern. It can be turned into a proper approach path if it enters too far to one side. It can do a normal descent at 4,000 feet a minute, or an emergency at about 14,000 feet a minute. It was easy to handle in precision approach, and could turn off the runway at well over 70 miles an hour at a 30-degree angle. We are ready for the jet as pilots, as aircraft engineers and as airport engineers, and grateful, of course, that they will enter our transportation picture gradually, and not suddenly in great numbers.

One of the world's greatest airports will be London Airport, which is still under construction.

What about the matter of jet noise? First of all, it is reassuring to know that the manufacturers of civil jet aircraft are diverting a substantial amount of engineering talent and dollars to the development of noise suppressors. Such devices add cost, and reduce payload, but both the makers and users have the vision to realize that their planes must be good neighbours in the communities they serve. To this end, they have pledged themselves to reduce jet noise to a level not higher than that of present-day piston engine aircraft.

If this goal is reached, and we take into account that the duration of jet noise is much shorter because of the more rapid climb-out, we might even find that the total noise problem is reduced rather than accentuated by civil jets. You will note that I say "civil jets". It should be realized that the jets being designed for civil use are quite a different breed of cat from the bombers which give most citizens their only concept of jet operations. The 707, for example, has been flown in and out of several civil airports without a single word of complaint being heard.

Some day we might be concerned with reducing the size of our airports. It is a possibility definitely in our future, but we must be realistic about it now. To accommodate existing planes, and the planes of perhaps the next 10 years, we of course need airports at least as big as we have today, and in some cases bigger. But this practice of building ever longer and longer runways need not be continued indefinitely.

We have the word of an aeronautical engineer, Grover Loening, backed up by that of engineers at the National Advisory Committee for Aeronautics, that some time in the future jet planes could be slowed down to 50 miles an hour and still retain their ability to fly fast. That would mean improved takeoff ability as well, and we would need far less runway than now for safe operation. I like to think of the great number of our problems which would vanish into thin air if we had such a plane as this, and I am not discounting the possibility that we will have it. Even now the military is realizing pleasing success in developing Short Take Off and Landing aircraft, and such developments ultimately are reflected in civil operations.

We know that airplanes can be improved. We know it takes a long time to do it. We know too, that we have been promised a wider spread between top speed and landing speed of transport aircraft for years, but that promise has never been realized. Nevertheless, it is reasonable for CAA, as the servant of the taxpayer, to continue urging this improvement.

European Air Transport

The present situation and future prospects, in comparison with the United States

By

Bo Björkman, Secretary General, Air Research Bureau, Brussels

The information contained in the following article comes, so to speak, "straight from the horse's mouth", since it is the author's job to feel the pulse of European air transport. Bo E. Th. Björkman, who was born in Stockholm in 1918 and holds an engineering degree, took over as Secretary General of the Air Research Bureau at the beginning of 1954. This organization was set up by four European airlines in 1952 to keep an account of its members' operations and of the whole of European air transport, to promote cooperation between airlines and to seek ways of improving operating methods. A.R.B. has its offices in Brussels, and its members are now Aer Lingus, Air France, Alitalia, British European Airways, Deutsche Lufthansa, Flugfelag Islands, Iberia, K.L.M. Royal Dutch Airlines, Sabena, Scandinavian Airlines System, Swissair. Editors.

There is no doubt that in the last few years European air transport has been the subject of much criticism, some of it ill-informed, and that in general it has had a "bad press".

To illustrate the point, I quote from reputable journals and research documents which are typical of the tone of such comments:

"The chronic deficit of the European network of airlines is, among economic problems, the major concern of the interested governments and their national airlines."

"Passenger traffic volume, route planning, scheduling, payload factors, operating costs . . . no matter which criterion is taken, there is no question that the Old Continent does alarmingly badly."

"Europe's airline industry, in order to become a paying proposition, must find ways and means of intensifying the use of its fleet and reducing its costs and its rates."

"Gaps in cooperation are largely responsible for the fact that frequencies and timetables are not always worked out with a view to providing a good service from point to point in Europe but show considerable signs of being the result of the requirements of long-haul connections. One could therefore say, to put it frankly, that from the point of view of internal connections, Europe is used rather than served, except on certain routes with a high traffic potential."

". . . . air fares for a comparable service are twice as high in Europe as in the United States."

The main points in these criticisms are:

a) That the European industry compares unfavourably with that of the United States;

b) that it does not or cannot pay;

c) that the cost and fare levels are too high;

d) that the network is purely a feeder operation and the carriers ignore the needs of the European market.

It is the purpose of this article to dispose of some of these contentions and to give some factual information about the present situation and prospects for European air transport.

Firstly, in making comparisons between Europe and the United States it is essential to appreciate the significance of the geographical and demographic factors:

• While the United States has a greater land area, Europe's "air space" is about the same, since it covers large areas of water, which are equally important when it comes to reckoning distances between cities. On the other hand national frontiers (Customs and passport barriers, language differences, etc.) are a handicap to the development of air transport in Europe.

• The United States has an advantage in the rapidly developing West Coast industrial region, which creates new long-haul transcontinental traffic. The bulk of their traffic potential, however, is of a similar character to the European, with a concentration within a well-defined industrial region of roughly the same magnitude.

• That traffic volume in the United States is eight times as great as in Europe, despite the basically similar geographical situation, is due primarily to the disparity between per capita incomes ($1,850 in the United States, $550 in Europe).

• European air transport planning is hampered by a lack of full statistical information (operational and financial). This is why phrases such as "the right of the national carrier", ". . . . the danger of competition", ". . . . a fair share of the traffic potential", or ". . . . the importance of Fifth Freedom rights", are so frequently heard. Consequently, too, the political control of air transport in Europe at the moment seems to be governed largely by fear: fear of losing, say, 5% of the traffic by granting certain freedoms to foreign carriers, when the traffic itself is growing at the rate of 20% per annum!

I do not wish to enter into any argument about the present trends in civil aviation politics in Europe: all I wish to emphasize is that whatever decisions are made, they should be based on facts and not on any pre-conceived ideas. The most important single factor is that traffic is growing at a fast rate, and all carriers are participating in that growth. Therefore steps to develop the total market and increase further the rate of development on a cooperative basis are much more likely to improve the individual airlines' operating results than protection by various artificial devices.

Profitability

With regard to the contention that European operations do not pay, this is far from the truth. For instance B.E.A. are now able to make a profit on their total operation, which includes their short stage domestic services. Aer Lingus, with an average stage distance of 350 kilometres, made a small profit in 1955/56, and Finnair is also making a profit. Each of the airlines mentioned is operating exclusively within the European continent. Although it is more difficult to separate the European from the total operation of those Europeans carriers which also operate intercontinental services, it is nevertheless true to say that a large number of European routes are now profitable and that the airlines operating them are doing so at or close to break-even, with a full allocation of overheads to their European activities.

Aer Lingus

Air France

Alitalia

BEA

Deutsche Lufthansa

Flugfelag Islands

Iberia

KLM

Sabena

SAS

Swissair

European air transport does not compare unfavourably with the U. S. air transport system. Picture shows the modern passenger lobby at Zürich-Kloten Airport.

Operating costs

In comparing costs, it is essential to bear in mind that in the United States the operation is purely domestic, and this makes quite an important difference to the cost structure, compared with the European, which is primarily international. In comparing the United States with Europe one must compare like with like, and the following table gives some comparisons as regards costs for United States' and European carrier total operations.

Costs per tonne/kilometre offered (1954) I.C.A.O. Statistics

	U. S. cents		
	Direct flying expenses	Indirect expenses	Total expenses
T.W.A.	12.5	8.8	21.3
K.L.M.	15.0	10.8	25.8
S.A.S.	14.6	11.9	26.5
P.A.A.	14.5	12.3	26.8
Swissair	14.6	13.2	27.8
Sabena	16.2	14.4	30.6
Air France	20.5	13.9	34.4

It is significant that the costs of T.W.A. are much lower than Pan American, since 80% of the former's operations are domestic. The true comparison should therefore be between Pan American and the European carriers.

Fares

With regard to fares, the European domestic fare level is an average of 13% higher than U.S. domestic and 4% lower than U.S. local. International fares in Europe are fixed by agreement between the carriers through the International Air Transport Association and are therefore comparable with U.S. international fares. If the total revenue rate of the European carriers for all classes of operation—domestic, European and international—is compared with the average rate for all U.S. carriers on all classes of operation, the difference is about 23% higher for the European.

The above are the fair comparisons to make with regard to differences in fare levels, and the following are typical single fares applying to comparable stages in the two regions.

Single fares on typical United States and European domestic routes (Winter 1956/57)

	Class	Stage distance kilometres	Single fare U. S. $	U. S. cents per pass./km
UNITED STATES				
Los Angeles–San Francisco	T	523	13.50	2.58
New York–Washington	T	345	11.40	3.31
Dallas–Houston	S	388	15.90	4.10
Chicago–St. Louis	S	403	16.55	4.10
New York–Buffalo	S	469	19.40	4.13
Minneapolis–Kansas City	S	675	29.45	4.37
Europe				
Helsinki–Kemi	S	625	15.50	2.49
Madrid–Barcelona	S	483	15.60	3.23
London–Glasgow	T	526	19.80	3.77
Stockholm–Gothenburg	S	401	16.40	4.10
Milan–Rome	S	483	20.00	4.28
Paris–Marseilles	S	628	28.80	4.59

S = Standard T = Tourist

Europe's needs not neglected

The contention that the European network is purely a feeder operation and that the European traveller is not catered for is certainly an unjust assessment of the present situation, and any analysis of the European timetables will illustrate this point. Furthermore 40% of the traffic in Europe is uplifted by carriers with no intercontinental interests, and of 10 million passengers emplaned in Europe in 1955, less than 1 million were proceeding to destinations outside the European-Mediterranean region.

Whilst in the past the intercontinental operation of the European carriers has been given high priority, there are now clear indications that increasing attention is being given to the European network, and it is significant that the carriers have in service or on order a number of aircraft types such as the *Metropolitan, Viscount 800, Vanguard, Electra* and *Caravelle* which are specifically designed for medium-stage operations. Also, it is hardly likely that European traffic would show a greater rate of development than in any other region in the world if the needs of the travelling public were being neglected. In the four-year period 1952—55, intra-European international traffic increased by 86%, domestic traffic by 93%, whereas U.S. domestic traffic increased by 59% and world traffic by 63%.

The following table gives some basic statistical data from the results of the member airlines of the Air Research Bureau, which can be regarded as criteria for the healthy growth and development of European air transport.

Intra-European Traffic of A.R.B. Member Airlines

	Pass./km (mill.)	Pass. index (1953 = 100)	Pass. L. F. %	Aver. stage dist./km
1953	1.576	100	57.4	522
1954	1.871	117	53.7	548
1955	2.337	148	59.9	569
12 months to 30. 9. 1956	2.718	172	60.8	566

It will be seen that there have been marked improvements in these various facets of the European situation, developments which will improve the revenue and tend to reduce unit costs. Average passenger trip length and average speed have also increased.

Frequencies

With regard to frequency of service, recent published statements indicate that the average frequency in Europe is one round-trip per day compared with 10 round-trips per day in the United States, which has led to adverse criticism of the European route pattern. But a close examination of the basic traffic data shows that the comparison is not correct. Calculation of average frequency should be based upon the unduplicated route network of the region (irrespective of carrier) and the above calculation of frequency for the United States is derived from the total length of certificated routes of 126,000 km. However, the total length of all the sectors operated in the United States is 340,000 kilometres (compared with 185,000 km for Europe), and the true frequency is therefore very much reduced. If the calculation of frequency is made on the correct basis for both regions, the respective frequencies are: Europe 9 round-trips per week, United States 28 round-trips per week, a ratio of three to one as against ten to one previously indicated.

*

The two main objectives of the air transport industry should be, on the one hand to operate on a sound economic basis, and on the other to serve the public need. With regard to the former, it will be noted that the passenger load factor has shown a remarkable increase in recent years, and, as stated by one of the top executives in the American air transport industry, "the passenger load factor is the key statistic for computing the economic health of an airline".

With regard to the services offered to the public, it seems doubtful that the traffic would have developed at such a high rate in recent years if the European airlines had ignored the needs of the European traveller. These needs have been met by offering the travelling public high standards of comfort, punctuality, safety and personal service.

Looking to the future, while there are certain physical and political handicaps to development, these should become of less importance as economic progress in Europe increases the standard of living, and more coordination between the European nations is developed through the Common Market and other schemes for European integration. Therefore the present situation and future outlook for the industry seem much more favourable than the pessimists would like us to believe.

U. S. Airlines Anticipate Mass Travel by Turbine Aircraft

By Stuart G. Tipton, President, Air Transport Association of America, Washington D. C.

Stuart G. Tipton was born at Knightstown, Indiana, in 1910. After graduating from Northwestern University Law School he joined the Legislative Division of the U. S. Treasury Department, where he aided in drafting the Bills which led to the 1938 Civil Aeronautics Act. Subsequently he became General Counsel to the autonomous Civil Aeronautics Authority (since split up into C.A.B. and C.A.A.) and in 1944 moved to the Air Transport Association of America as General Counsel. He was elected A.T.A. President in December, 1955. Editors

The scheduled air transport industry of the United States faces the future with what might be termed balanced optimism—that is, full awareness of the many and complex problems but at the same time a firm conviction that progress will continue.

This kind of basic confidence is not surprising since the industry has grown so tremendously in less than 20 years. The major law, the Civil Aeronautics Act, was passed by the Congress in 1938 and so we often measure our growth from that date. For instance there were about 1,500,000 passengers carried in 1938—in 1956 there were over 47,000,000 passengers.

This progress, however, was not presented to us. The American-Flag airlines have had to struggle ceaselessly to provide increasingly better service to an ever widening mass market. Now, with the introduction of turbine power, the industry is heading for new heights of operations and service.

The Vickers *Viscount* turboprop aircraft is already in service in the U.S. However, bigger turbine-powered aircraft are scheduled to go into service in 1959 and 1960. Some will be the larger turboprops, such as the Lockheed *Electra* and the Bristol *Britannia*. But there will also be large fleets of Boeing 707's, Douglas DC-8's, Convair 880's and *Comets*, the large pure jet airliners. And some of the turbine-powered aircraft will be destined for short-haul service. Some of the local service airlines have already ordered the Fokker-Fairchild F-27, a turboprop designed for short-haul operations. Inevitably, there will be efforts to apply turbine power to other short-haul vehicles, including the helicopter.

How many jets will there be? To date the American Flag industry is committed to purchase 397 pure jet and turboprop airliners. The cost will be $2,600,000,000, including the standard 20% purchase of spare parts. These do not include *Viscounts* already delivered. Of that sum, $2,500,000,000 will be represented by turbine engine airliners produced in the United States. Turbine aircraft produced in Great Britain will account for a little over one hundred million. Of the 397 turbine airliners now on order, 213 will be pure jets.

The U. S. air carrier, Northeast Airlines, has ordered Bristol *Britannia* turboprop airliners.

The airlines of the free world, including the airlines of the United States, now have on order 722 turbine airliners. Of that total number, 457 will be built in the United States, 265 in other countries. All of the orders for the largest and heaviest types are placed with U.S. manufacturers.

A typical big jet airliner may weigh close to 300,000 pounds, as compared with 145,000 pounds for the largest airliner in regular service today. It will have a lift capacity of 40,000 pounds, as compared with 23,640 for a typical big airliner today. In tourist configuration, it will offer up to 150 seats, as compared to the 95 seats available on a typically large tourist-class plane today. And the large jets will have non-stop ranges extending to 5,900 miles.

The big jets of the future, with cruising speeds of approximately 550 miles an hour, will also offer, with respect to noise and vibration, a more comfortable service than is offered even by the fine new planes of today.

Generally speaking, these aircraft will provide basic problems in three areas: Who pays for them? How annoying will they be to neighbours? And how can an already overloaded and inefficient air traffic control system handle these newcomers?

Since 1946, some 82% of all funds available to the air transport industry has gone into new equipment, which is to say into improvements in service. But the value of all the property owned by the U.S. airlines today is $ 1,500,000,000, whereas the commitment for turbine aircraft already amounts to $ 2,600,000,000 and there is an additional $ 500,000,000 of piston-engine aircraft on order. It is estimated that the next nine years will see that total expanded to at least $ 4,700,000,000, including ground equipment.

Will airline expenses be limited to equipment expenditures? Perhaps new reservation systems must be invented and applied—a joint airline committee is already re-exploring the field of electronic equipment. New ways of handling your baggage must be devised. Airline people must

The Boeing 707 jet airliner has been ordered by a large number of U. S. and foreign air carriers. The prototype is shown flying over Puget Sound.

be re-trained in the care and servicing of the new aircraft; and some airlines are thinking of investments in new and ingenious forms of ground equipment to expedite loading and unloading.

And where will this money come from? Or put differently: How much will it cost you to ride aboard a turbine airliner? I know of nobody who can answer that question with certainty today. In 1957, the average domestic airline fare stands about where it did in 1938, the year of the passage of the Civil Aeronautics Act. It costs you, in fact, just $ 1.80 more to fly between Washington and Chicago on a first-class flight than it did in 1938. It costs you $ 11.30 less if you go by aircoach. And in either case, the service is faster, more dependable, and more comfortable than it was in 1938.

Since 1938, general costs in the United States have nearly doubled. The price of bread, for example, has tripled. Average airline wages have more than doubled. Even bus fares have increased 27%. First class rail fares are up somewhat less than 50%. Yet, the average domestic air fare shows only a slight increase, if any. The American Flag carriers, of course, have been among those who have taken the lead to successfully reduce international fares.

What has happened, you see, is that increasingly efficient management, spurred by competition, has used ever-improving technology to resist and overcome the very great rise in general cost levels which has occured since 1938. Now, however, costs appear at last to be catching up with both technology and management. This development was inevitable. It was obvious that the airlines could not continue forever to swallow constantly increasing costs. That is why today there is talk of a moderate increase in airline fares.

In terms of seat-mile costs and seat-mile revenues, it is hoped that the new turbine aircraft will be at least as productive and perhaps more productive than are today's airliners. Because the airlines are firmly committed to expanding their market—as witnessed by the growth from 1946 to today—and because an expanding market requires the lowest fares consistent with sound operating economics, it can be stated that the fares for turbine-powered travel will be reasonable when compared with the costs of other goods and services in the economy of 1960. But it is plain that the exact fare level—which in any event must be passed upon by the United States Civil Aeronautics Board—will be determined in very large part by what happens to the general level of costs between now and the time at which the new aircraft go into service.

Another question we face is, will jets, along with all their wonderful advantages for those who wish to travel for pleasure, for emergency, or for business, be so obnoxious that we will not want to have them around? The major question raised so far concerns noise.

We have heard quite a few dire forecasts. The pessimism stems, of course, from the operation of military jets. But there will be differences between the big military jets and the new jet airliners.

Air transport vistas

The military, of course, cannot sacrifice—and no American wants them to sacrifice—even one ounce of thrust in a jet engine. That ounce could literally be the difference between life and death. The airlines can sacrifice some power to achieve noise reduction. Naturally, we want to sacrifice as little as possible. But the fact is that every American Flag airline purchasing jets has stipulated that the engines must be equipped with noise suppressors. And the expectation is now that the noise of jet engines will be no greater than the noise of today's big piston-engine types. In addition to the relatively small noise envelope expected from the Boeing 707, jets have a more rapid rate of climb than do today's aircraft, with the result that the noise will be dissipated more quickly.

The amazingly fast jets, with their equally impressive appetites for fuel, will present new problems in the air traffic field. It may be difficult for some to realize just how crowded the skies over American cities have become in the last few years. Perhaps this comparison will help. Louisville, Kentucky, handles more air carrier traffic than both the airports combined at Paris, France. However, Louisville ranks twentieth among airports in the United States, trailing well behind such other major centers as New York, Chicago, Miami, Los Angeles, and Washington.

The air space over airports will become more crowded in the years to come. Not only crowded but increasingly complex, for the air traffic control pattern of the future will include supersonic military jets, 550-mile-an-hour commercial jet transports, and 100-mile-an-hour helicopters—all at the same time and all desiring to land efficiently and safely.

Of course, the troubles have developed ahead of the arrival of jets. President Eisenhower has appointed a special assistant to conduct a comprehensive study and provide a long range plan. This should be released for public discussion shortly. We are confident that the traffic control problem will be solved so that we can continue to combine safety with efficiency.

The airlines face all these admitted burdens with optimism. They are certain that the result will be worth all the effort. Scheduled air transport, as is evident by the statistics, has grown continuously in usefulness since 1938. The advent of the jets should permit it to make a quantum leap in usefulness. But that leap will not be made, the airlines know, without an intensification of the already vigorous campaign to sell the use of air transportation—for travel, for freight, for express and for mail.

Traditionally, new methods of transportation have wrought revolutions not only in the way in which people do business but in the way in which they live. There is no need here to rehearse the past and continuing contributions of such forms of transportation as the railroads, or the highways and the vehicles which move upon them. And in talking about the impact of jet travel upon the traveller and the shipper, I think it is enough at the moment to content ourselves with the broad but factual statement that the jet airliners will bring about a revolution in the way in which men think. The single fact that the intercontinental distance between Europe and North America can, for the first time, be measured intelligibly in minutes instead of miles is a signpost on the way to change.

The American Flag airlines are gearing up for continued growth. By its nature this business, operating on a low profit margin, is lean and muscular, rather than fat and lazy. This lack of a profit cushion produces problems, sometimes serious ones, in an ever expanding competitive market that requires money constantly for the improvement of service.

However, the goal is to bring the benefits of the air age to every place in our country and throughout the rest of the free world on an efficient, safe and economic basis. The new transportation dimension of mass movement of people by air as well as underground or on the surface, is about to become a reality, and the members of the Air Transport Association as well as the other imaginative, competitive airlines in the world are accepting the challenge to provide this service.

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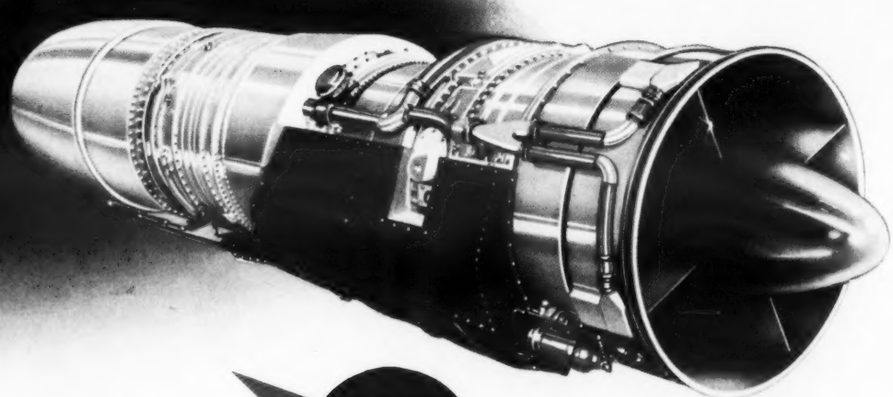

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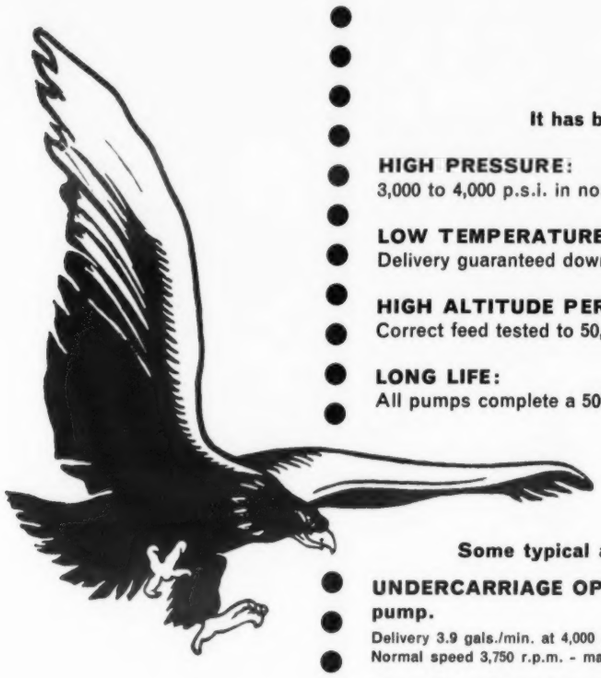

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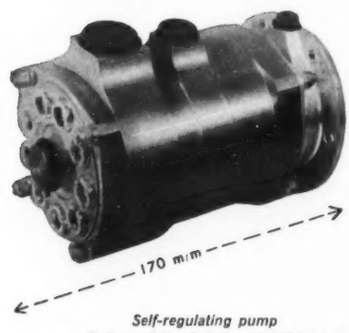

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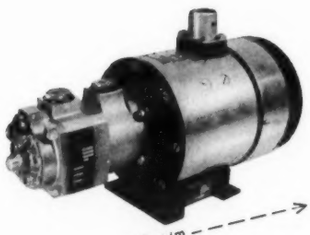

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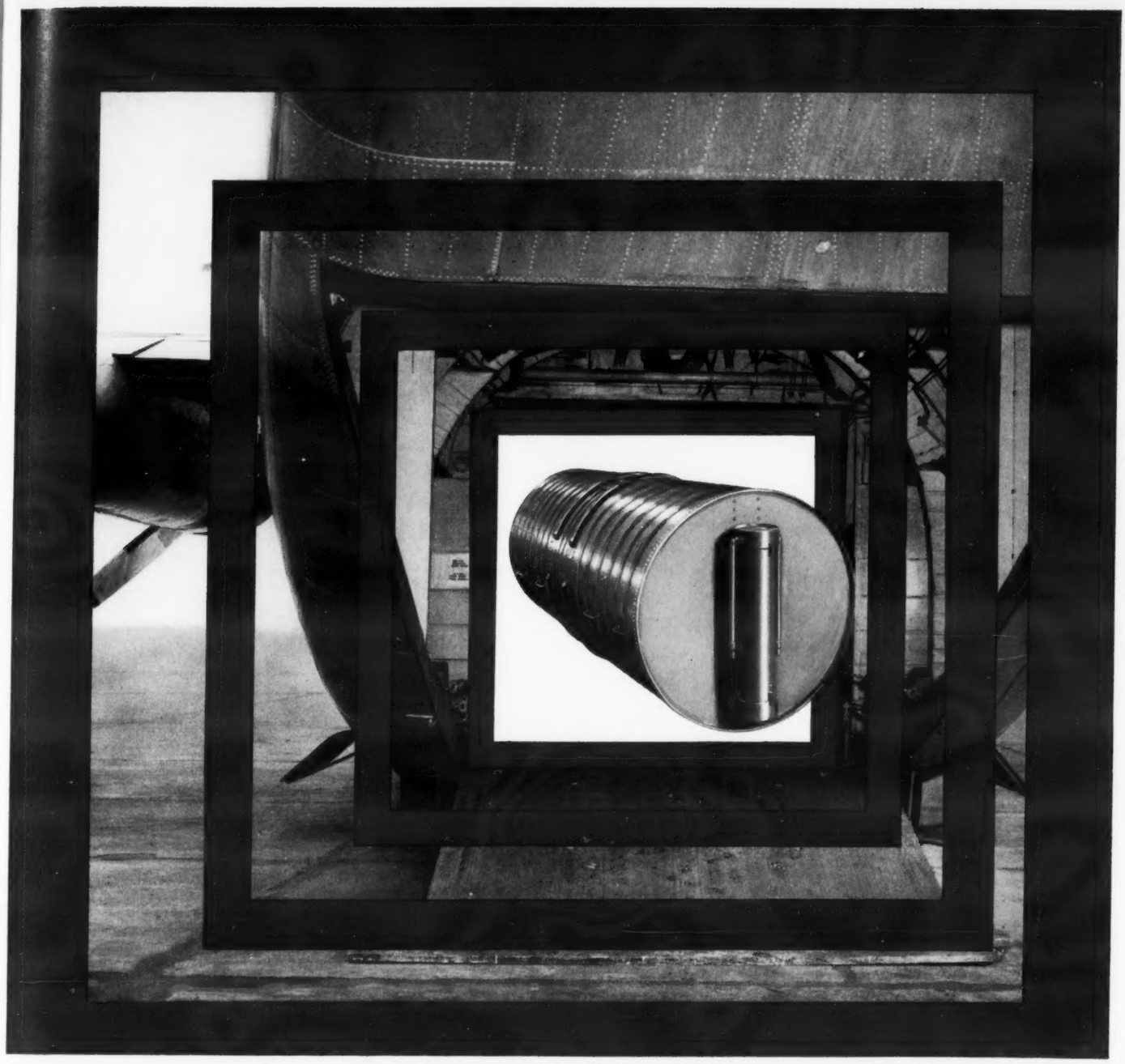
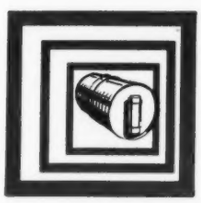


Fits into the framework of logistics



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LIGHTING ELECTRONICS ATOMIC ENERGY
TELEVISION-RADIO PHOTOGRAPHY CHEMO-METALLURGY

Flying the Boeing 707 Jet Transport

By A. M. "Tex" Johnston, Chief of Flight Test, Boeing Airplane Co., Seattle, Washington

Alvin M. "Tex" Johnston has a long record of experimental flight tests behind him. He was the project pilot on the B-52 Stratofortress *175-ton eight-jet long-range bomber until he was appointed Chief of Flight Test on September 1st, 1952. He now directs a staff of 600, including 25 test pilots, but he still spends much time in the air at the controls of the Boeing 707 jet transport and tanker and of the B-52.*

Johnston, who has now more than 12,500 hours of flight time, including 2,500 hours in jets, was born at Emporia, Kansas, on August 18th, 1914. After graduating from High School he learned to fly and joined a flying circus, specializing in acrobatics in—a Ford tri-motor! He left barnstorming to study aeronautical engineering at Kansas State College and at the University of Buffalo, joined the U.S. Army Air Force before the war and changed over to Bell as an experimental test pilot in 1942. Among many other types he tested was the Bell X-1 experimental aircraft, the world's first supersonic aircraft, and in 1946 he won the Thompson Trophy Race at 376.4 m.p.h. in a modified P-39 Airacobra *piston-engine fighter.*

Johnston joined the Boeing Airplane Company in July 1949 as a project pilot for the B-47 Stratojet *bomber. He was assigned as a project pilot to the B-52 programme in 1951.*

Editors

When an airline pilot gets into the cockpit of the Boeing 707 jet transport prototype for the first time, he has difficulty believing what he sees and hears and feels. I've had the pleasure of conducting a number of demonstration flights for such pilots and I've had a lot of fun watching their reactions.

Dan Beard and W. W. Braznell of American Airlines were typical of many pilots on their first jet transport flights. Beard is Assistant Vice-President in charge of Research and Development and Braznell is Director of Flying Operations for American Airlines, which has ordered 30 of the Boeing jet transports. In September of 1955 Beard and Braznell came to Seattle to see what kind of an airplane their company was considering to buy.

The two men got aboard the Boeing 707 prototype expecting to sit in back seats while I flew the plane. Braznell never had flown anything except piston-engine planes. Beard had a little experience with jets, but not much. They were startled, to say the least, when I got in the co-pilot's seat and asked which one of them wanted to fly it first.

Alvin M. "Tex" Johnston, Boeing's Chief of Flight Test, leaves the pilot's seat of the Boeing 707 prototype.

As Braznell said later, he didn't know whether I had the mistaken idea that he and Beard were experienced jet pilots, or whether the prototype was so easy to fly that even a couple of inactive line pilots could not get into trouble with it. The latter case is true, with certain limitations.

Beard gingerly got into the pilot's seat and fastened his safety belt while he looked over the cockpit. It must have seemed to him that we had forgotten to install a considerable number of the controls and instruments which he was accustomed to seeing in large piston-engine transports. Airline pilots are at first surprised and then very much pleased by the simplicity of the Boeing 707 cockpit.

Boeing 707 prototype taxiing at Boeing Field, Seattle.

The 707 takes us back several years in control and cockpit simplicity and it is a welcome change. This 600-mile-per-hour jet plane was designed to give pilots a break. The number of its controls and instruments has been reduced to about 50 percent of the number in an average large piston-engine transport, such as the Boeing *Stratocruiser*.

The Boeing 707 has 115 fewer power-plant controls and instruments than the *Stratocruiser*. Consequently, the new four-engined jets are easier to fly than the old Douglas DC-3 with its two piston engines.

The main thing that has simplified operation of the Boeing 707 is its jet engines. A jet-engine control is as uncomplicated as a broom handle. It is a single lever mechanically connected to a hydromechanical regulator on the engine. Push it open and the engine accelerates. Pull it back and the engine slows down. Fuel-air ratio takes care of itself.

I went over the necessary explanations quite briefly with Beard and Braznell. I did this before we started the engines, as there is no need for a warm-up period with the four Pratt & Whitney JT3 jet engines, which are commercial adaptations of the J57 engine used in the Boeing B-52 *Stratofortress* and certain other military airplanes. These engines have been in use for a number of years and have proved very reliable. Their trouble-free performance during nearly three years of test-flying the 707 prototype is a good omen for the jet transport's operational future.

Basic flight controls and instruments of the Boeing 707 are the same as on any airplane, so Beard had no difficulty whatever in this respect.

After a few minutes' familiarization he was ready to go. We started the engines and he taxied out to the runway. Then he applied the power and away we went. About half way down the runway, Beard lifted the 707 prototype into the air as smoothly as if he'd been doing it all his life.

Not all the experts agree that pilot conversion from piston engine to jet transport is as easy as it has been made out to be. Major General (ret.) Victor E. Bertrandias, former Inspector General of the U.S.A.F. and now an on-call adviser to Pan American World Airways, is one of those who is concerned about the training of tomorrow's jet transport pilot. For instance, he believes that pilots in the over-40 age group will simply not be able to make the transition. "There is too much complacency on the part of the airlines toward conversion", he told *Interavia*'s West Coast Correspondent, "and this can lead to serious difficulties when the jets finally enter operation." The airlines should turn to the military for help in converting from piston-engine aircraft to jets. However, the airlines had so far refused to take full advantage of Air Force jet symposiums and other offers of aid; indeed, the airlines had been indignant at suggestions that the military had anything to offer. Bertrandias said that the manufacturers, on the other hand, were doing all they could to help in solving the problem.

It should be noted that the prototype had a small load of fuel and its gross weight was only about 142,000 pounds. I do not wish to give an impression that a fully loaded operational Boeing 707 jet transport will be as light or require such a short run for takeoff.

An operational Boeing 707-320 Intercontinental jet airliner will have a maximum gross weight of 295,000 pounds and a maximum landing weight of 195,000 pounds. Obviously these airplanes are going to have somewhat different operational performance than the prototype with a light load and its engines of lower thrust rating. Takeoff and landing speeds of the operational 707s will be appreciably faster than of the prototype with a light load. However, the operational 707s will have speed and climbout performance considerably exceeding that of any piston-engine transport.

For about 1½ hours Beard and Braznell took turns flying the prototype. They made repeated landings and takeoffs and put the aircraft through a very thorough series of tests. There is no problem of carrying on a conversation in the Boeing 707 cockpit, as there is almost no engine noise. About all that can be heard is the sound of air whistling over the nose structure of the airplane. There is no vibration, either. The pilots are almost as comfortable as if they were sitting at home in rocking chairs.

Visibility from the cockpit is very good. Even the frames in the windows have been slimmed to allow binocular vision past them, an eye on each side. There are four windows in the roof, two above each of the pilots. When the plane is banked in a turn, the roof windows afford good visibility into the area the plane is entering. This is a considerable advantage when making an approach to a landing field.

I demonstrated the simplicity of air starts by flicking a switch and placing the throttle in the idle-start position. The simplicity of this operation is a good example of the ease of flying with jet engines compared to piston engines.

Gone are propeller-pitch controls, mixture controls, cowl-flap controls, carburetor-heat controls, supercharge controls, propeller-synchronizer control and many others. Reducing the number of controls and instruments not only makes life easier for the pilots, but improves operating safety.

A great deal of attention was given to safety aspects during design of the Boeing 707. Opportunities for error have been reduced and non-essentials eliminated. For example, simple hydraulic snubbers on control surfaces replace manually operated gust locks and eliminate the possibility of "forgetting errors". The 707 wing has an inherent aeroelastic characteristic which combines with sweep to reduce the effect of gusts upon wing loading. Upon striking the gust, the wing bends along its elastic axis, causing effective washout of the wing tips. Washout relieves the loading and reduces wing bending to minimize the effect of the gust.

Beard and Braznell found that the 707's eight-wheel bogie main landing gear provides large footprint area for good braking. Effectiveness of the brakes is increased by wing and gear geometry which permits early transfer of weight from wing to wheels. Use of speed brakes further unloads the wing to improve braking effectiveness and adds some drag.

Another of the many airline pilots who found that their first ride in the Boeing 707 prototype was a remarkable experience was Anthony Spooner, senior captain of British Overseas Airways Corporation. I got him into the pilot's seat and then gave him a surprise by telling him to unlock the brake and take the

The simple cockpit of the Boeing 707. In the pilot's seat at left is Braniff Airways' Chief Pilot Dan Hughes Jr., in the co-pilot's seat is R. L. "Dix" Loesch, Boeing Senior Experimental Test Pilot.

Boeing 707 immediately after take-off.

plane off. He went ahead without hesitation, but became even more startled at the plane's performance. Acceleration of the 707 at takeoff is nearly 40 percent greater than that of a piston-engine aircraft such as a *Stratocruiser*.

Spooner lifted the 707 jet prototype into the air as smooth as silk, but immediately found that he was climbing at the rate of 4,000 feet per minute and his air speed was increasing rapidly. He held the plane in a steep climb to hold down the speed while he retracted the flaps. Spooner had no trouble at all with the controls, but it took him a little time to familiarize himself with the instruments. The air-speed pointer makes a complete revolution each 100 knots and for a minute or two he wasn't sure whether he was going 200 miles an hour or 300. Similarly, the altimeter was winding up so rapidly that he couldn't keep track of it. In eight minutes he was at 31,000 feet elevation and completely astonished.

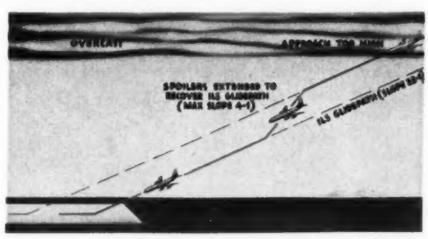
This is a good place to note that the Boeing 707 has power capability to exceed its level-flight placard speed. A pilot must be careful to keep out of this area.

Spooner later asked me to simulate an emergency descent—apparently he wanted to know if we could get down as fast as we went up. We were cruising at 310 knots IAS at 33,000 feet. We closed the throttles and raised the spoilers to full braking position. When our speed was down to 270 knots I extended the landing gear. By this time we were going down very sharply. In 1½ minutes we went down 18,000 feet.

On the way down Spooner checked and found that he had good lateral control at all times. He also cut out an outboard engine and then relit it without any difficulty.

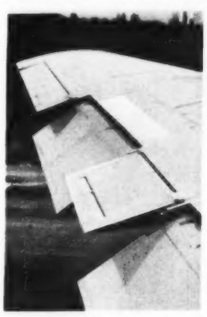
Lateral control of the Boeing 707 is obtained by mid-span, high-speed ailerons supplemented by hydraulically operated spoilers and, when flaps are down, by outboard or low-speed ailerons. Operation of flaps adjusts the linkage between inboard and outboard ailerons to permit outboard operation only by extended flap. This arrangement permits a rolling rate —flaps up or down—considerably in excess of that in older transports and ensures good manoeuvrability at all speeds with excellent lateral control at landing. This lateral control may be utilized to permit the aircraft to operate safely from airports with a 90-degree crosswind of 30 miles per hour.

The spoilers, used primarily to suppement lateral control, may be used symmetrically for speed brakes. Use of the spoilers also gives a pilot a wider choice of approach angles for landing than is available in most propeller-driven transports. The spoilers readily correct for a high or fast approach.



Spoilers enable the Boeing 707 pilot to correct for a too-high approach to the runway.

Take-off: flaps are partially down *(left)*. Let-down: flaps are down, spoilers are extended as needed to act as air brakes and help control the rate of descent.



Spoilers used as speed brakes are very effective in decelerating the airplane and may be employed by a single motion of the pilot.

Spooner made some 60-degree bank turns at Mach .83 and found that he could do them with one hand, exerting far less effort than is required for a similar manoeuvre with a large propeller-driven aircraft.

Primary flight controls of the Boeing 707 are 100-percent manually operated. In the interest of simplicity, reliability and safety these controls all are actuated by spring tabs, connected by cable to the pilot's wheel and rudder pedals. Use of internal pressure balances permits tailoring of the systems to give low control forces at low speed for good manoeuvrability and higher forces at high speed where abrupt manoeuvres are undesirable. This provides optimum natural "feel" and avoids both sluggishness and over-sensitivity.

After about an hour of thoroughly checking the jet transport, Spooner headed back toward Boeing Field. He figured out his own approach on the landing circuit and brought the big jet in as lightly as a feather. I suggested that he open the thottles and make it a touch-and-go.

The prototype responded to the wide-open throttles with its characteristic surge of speed. Spooner almost immediately found himself in the air again with the nose pulled up sharply to hold speed down until he could retract the flaps. He brought the plane around to another gentle landing and this time braked to a stop.

Spooner and about 50 other airline pilots who have taken the 707 up, flown it and landed it without previous experience on jets have all commented that the aircraft was very easy to fly.

The first two *Caravelles* over the Alps. The 02 prototype is in the foreground.

Flight Testing the Caravelle

In the two years since the SE. 210 *Caravelle* jet-propelled commercial transport made its first flight on May 27th, 1955, the two prototypes, 01 and 02, have accumulated roughly 1,500 hours of flying time. The lion's share has been borne by the 01 prototype, which had reached 1,000 flying hours as long ago as the end of October 1956.

The following brief review recalls the successive stages in the *Caravelle*'s development, from the beginning of the project work up to the end of the first prototype's endurance tests, and clearly illustrates the achievements of the manufacturers, Sud-Est Aviation (now merged with Ouest Aviation in Sud Aviation):

October 1951: Project submitted to authorities.

January 1953: Official decision to develop the SE.210.

February 1953: President of Sud-Est Aviation orders building of two prototypes.

April 1953: Manufacture of first parts; contract for two prototypes signed.

September 1953: Beginning of fuselage assembly.

March 1954: End of fuselage assembly.

April 1954: Wing box spar mated to fuselage, beginning of final assembly.

December 1954: Completion of fuselage and its acceptance after pressure tests.

April 21st, 1955: Completion of prototype and transfer to the manufacturers' flight test section.

May 13th, 1955: First test runs of the jet engines.

May 18th, 1955: First taxi tests.

May 27th, 1955: First flight (airfield circuit).

February 28th, 1956: End of works testing: total flying time 266 hrs 35 mins. in 117 flights.

February 29th—May 18th, 1956: Flight testing at Brétigny Flight Test Centre; total flying time 118 hours in 179 flights.

May 6th, 1956: First flight by second prototype.

May 23rd, 1956: Beginning of endurance tests.

September 30th, 1956: Completion of endurance tests.

October 28th, 1956: First prototype completes 1,000 flying hours.

Works testing of the complete aircraft

Pressure cabin: The *Caravelle* is designed to fly at a cruising altitude of roughly 40,000 ft. with a cabin pressure equivalent to 8,200 ft. so that the fuselage walls have to withstand a pressure differential of 8.25 p.s.i. To check the design office's strength calculations, a part fuselage with window cut-outs and emergency exit was submitted to the following water tank tests:

1. Stressing with an internal pressure of 18.1 p.s.i. (normal internal pressure 8.25 p.s.i.);
2. Torsion on the airframe up to the "safe" load;
3. Torsion on the airframe (as above) with simultaneous application of an internal pressure of 10.4 p.s.i.;
4. Alternating load test with 40,000 load cycles (cyclic application of an internal cabin pressure of 9.05 p.s.i.; later, increases in the alternating pressure to 12.1 p.s.i. and 18.1 p.s.i.).

The water tank tests not only proved that the airframe is absolutely airtight, but also provided an opportunity of measuring the cabin deformations due to the pressure inside the fuselage, determining the stresses around the fuselage cut-outs and ensuring that no permanent deformations remain after decompression. The stresses measured in no case even approached the permissible maximum values and showed no critical accumulation in their distribution.

Functional testings: In addition a large number of laboratory tests was also carried out, including testing of the hydraulic and electrical systems. In many cases complete sub-assemblies (undercarriage retraction mechanism, power-boosted controls, etc.) were subjected to tens of thousands of individual tests under realistic conditions.

Works flight tests

Eighteen manufacturers' flights totalling 24¼ flying hours were devoted to an investigation of the *Caravelle*'s general flight behaviour. Although minor modifications were found to be necessary, this first flight test series was so satisfactory that the aircraft was able to land at an airfield away from home after only ten flights and was demonstrated to visitors of the 1955 Paris Air Show on its sixteenth flight.

The prototype was then placed at the disposal of O.N.E.R.A. experts for several weeks, for extensive vibration measurements. Then flight testing was resumed early in August 1955, thereafter being interrupted only by occasional inspections and the routine replacement of the Rolls-Royce *Avon* jets. — The following are the most important results of the flight testing.

Mach number: The highest Mach number attained was 0.84, at an altitude of approx. 39,500 ft. after a shallow dive from 42,500 ft. No instability, loss of control surface efficiency, etc., occured.

Max speed: At an altitude of 15,000 ft. max. indicated air speed was 340 knots (TAS ~ 430 knots).

Service ceiling: The greatest barometric altitude reached was 43,000 ft., under temperature conditions which, when converted to standard atmosphere, give a pressure altitude of 43,400 ft.

Flying qualities: Throughout the speed range excellent longitudinal and transverse stability and good controllability were observed with both the most forward (25% M.A.C.) and the most rearward (39%) centre of gravity position.

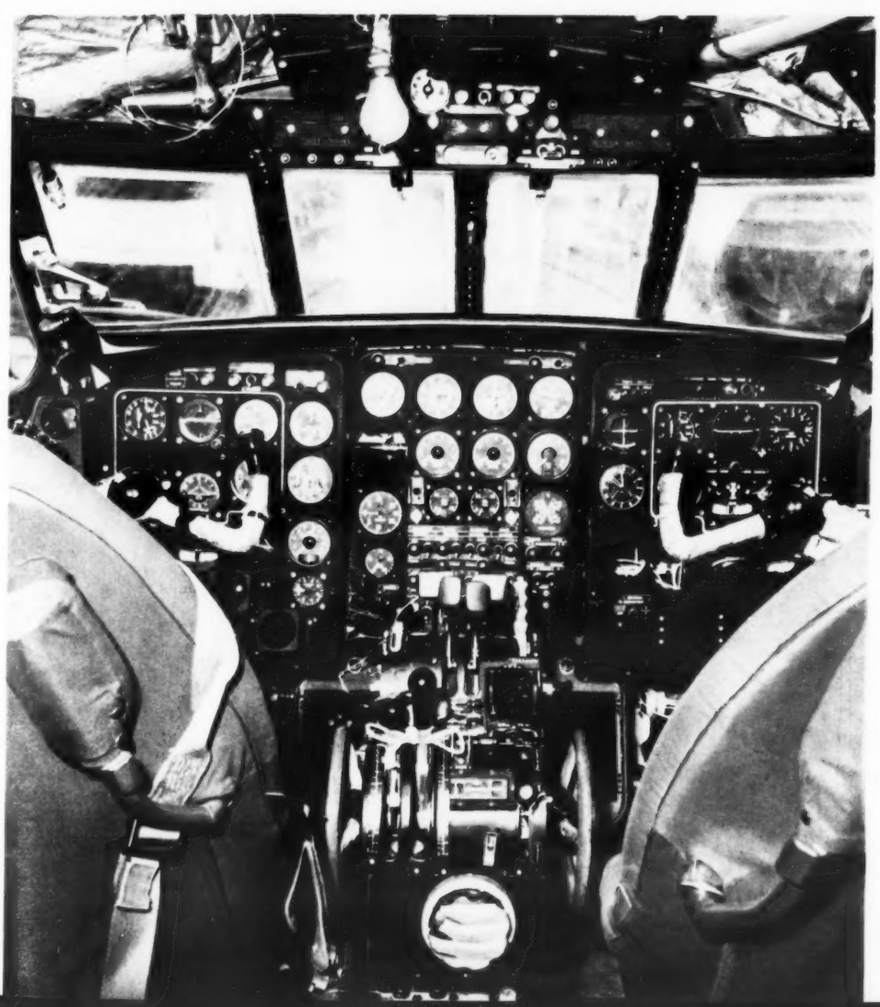
Stalls: In more than a hundred cases, a flow breakaway on the wing was provoked, under varied aerodynamic conditions (modified setting of leading edge slats, air brakes, landing flaps and undercarriage), with varying engine thrusts (full rev. speed, reduced rev. speed, asymmetric thrust) and finally in varying flight situations (straight-and-level flying, turns, climb, etc.). The stall oscillations were never rough and were of moderate amplitude. The aircraft immediately became controllable again, with no vibrations or flutter occurring.

Air brakes: A series of test flights proved that the air brakes on the upper and lower wing surfaces can be operated at speeds of up to Mach 0.81, and in emergencies give a rate of descent of 10,500 ft./min.

Take-off and landing: Take-off tests were made with progressively increased weight until the maximum permissible take-off weight of 90,400 lbs. was reached. Then the power of one of the two engines was throttled back step by step at the critical point during take-off, until it was cut completely. Here it was found that the requirement for "positive rate of climb on one engine" can be met even with a take-off weight of more than 90,400 lbs.

For a take-off speed of 120 knots and a gross weight of 90,400 lbs., take-off run on two engines is roughly 3,600 ft. Critical speed for failure of one engine in this case is 114 knots, so that the required runway length (acceleration—stop distance) is 5,580 ft. Landing distance from an altitude of 50 ft., with a landing weight of 86,000 lbs, is 3,740 ft.

The arrangement of the engines one on either side of the rear fuselage makes for a low noise level inside the cabin. Door for built-in passenger steps underneath the rear fuselage.



The crew compartment.

Endurance testing at Brétigny

The subsequent endurance testing by crews of the Government Flight Test Centre at Brétigny and by Air France included flights to Algeria (more than 40 two-way trips, including two non-stop flights from Algiers to Paris on one engine) and to Morocco (Paris—Casablanca in 2 hrs. 35 mins.). Tests were also made to determine the *Caravelle's* maximum daily operating performance. On certain days over 14½ flying hours were recorded. Finally, demonstration flights were made to Switzerland (Geneva and Zurich), Germany (Cologne, Düsseldorf, Hamburg), Belgium (Brussels), Holland (Amsterdam), Sweden (Stockholm) and Portugal (Lisbon).

The 01 prototype is now undergoing a general overhaul and inspection, lasting several months, designed primarily to investigate the airframe's fatigue strength. The 02 prototype has now completed more than a hundred flying hours. It differs from the first prototype in details of airframe design and above all in its drooped leading edge (instead of the slats in the first prototype). This second aircraft is to make a demonstration tour of North and South America in April and May this year, visiting some 25 airports.

At the end of 1956 the third prototype left the assembly shed at Toulouse for a four-months' series of fatigue tests in the water tank. During this time the airframe will be subjected to the stresses that would normally occur during 15,000 flights totalling 40,000 flying hours. Finally, a fourth prototype will be used for conventional testing to destruction.

Design and structure of the *Caravelle* were described in detail in *Interavia* eighteen months ago. (No. 10, 1955, pp. 770—773); comparative performance figures appeared in No. 3, 1956 (p. 177).

Air transport vistas

A Pilot's Impressions of the "Friendship"

By Leo W. Killen, Geneva

Leo W. Killen, 37, a former colonel in the U.S. Air Force and now the Director of European Operations for Fairchild Aircraft in Geneva, Switzerland, has had over 20 years experience in the field of aviation. He has recently flown the Fokker designed F.27 Friendship *which is being built under licence in the United States by Fairchild.*

His reactions and analysis as expressed in this article are those of a pilot who has had varied flight experience in the U.S.A.F.'s Strategic Air Command, the Military Air Transport Service and the Air Research and Development Command. Killen started his flying career in the middle 30's in an OX5 Travelair and has progressed with the times in flying the most up to date equipment. His experience has been largely in multi-engine aircraft, including the Boeing B-17, Consolidated B-24 and Boeing B-29 during World War II, the Boeing B-50 and North American B-45 during the Korean campaign and, prior to his retirement in 1953, the six-jet Boeing B-47. Editors.

As a result of Fairchild's association with the Fokker Aircraft Company through our licence agreements and my personal friendship with Hugo Burgerhout, Fokker's Chief Test Pilot, I have had the opportunity of flying the first prototype of the Fokker F.27 *Friendship* twin-engined turboprop medium-stage airliner. And I must say quite sincerely that I agree with Paul Beech, Chief Test Pilot of Bonanza Airlines (which has ordered three F.27's), who said later on that "if you want to sell more of the airplanes, just let the pilots fly it . . ."

As you approach the *Friendship*, the first impression you get is that the aircraft is well constructed, safe and, at the same time, sleek and efficient in appearance. Entering the cockpit, you are struck by the simple, standardized arrangement of controls and instruments, as well as by the good visibility to the sides and rear, which makes it easy to observe the ground crew at the airport as well as the engines during the starting operation and in flight. The reasons for this are twofold: a large windshield and side windows, and the high wing configuration to which most pilots of today are unaccustomed but which they would have often welcomed during starting and flight operations.

I had never flown an aircraft with turboprop engines and I was pleasantly surprised by the simplicity of the 1-2-3 starting procedure: (1) Arm starting circuit, (2) Open HP fuel cock, (3) press starting button. A closer look at the cockpit arrangement showed that the engine, trim tab and emergency controls are all within fingertip reach. The instrument panel is so arranged as to provide maximum readability of all instruments. The nose wheel steering control is unusual inasmuch as it easily falls into the left hand as the taxi operation is started.

The excellent visibility and pneumatic brake system—the latter was also a "first" for me—made the taxi operation a pleasure. By this time I was getting accustomed to the turboprop engines, and my apprehension turned to a desire to become airborne and investigate the aircraft's handling characteristics in the air. As we rolled onto the runway and I pushed the throttles forward, the acceleration was very firm and quite astonishing, particularly when compared with a straight jet operation. As we approached the unstick speed of 92 knots and I eased back on the control column, we left the ground in a very positive but conventional attitude after using less than 2000 ft. of runway. Hugo immediately feathered the No. 2 engine, but with little rudder pressure I was able to maintain a straight flight path while trimming up the aircraft to a hands-off condition. At this critical flight period I was pleased to find that the airplane had very little tendency to yaw or become difficult to control.

The single engine climb-out performance is excellent. At 13,600 r.p.m. (cruising power) we were able to climb at 400 feet per minute at an indicated air speed of 115 knots. During the single-engine climb-out, I made several turns into and away from the dead engine and found the airplane stable and easy to handle. At 6000 feet we leveled off and Hugo suggested that I try a series of single-engine stalls. Some time had passed since I had fully stalled an airplane, primarily because my past ten years had been spent in four to six-engine aircraft of weights of 150,000 to 200,000 lbs. in which one normally doesn't perform such manoeuvres.

The two *Friendship* prototypes: No. 1 is at left.

Fokker F. 27 *Friendship*, second prototype.

However, with faith in Hugo and confidence in the *Friendship*—after only a few minutes on the controls—I conducted a complete series of stalls, single-engine, two-engine, power-on, power-off, landing gear and flaps up and down, in turns and in straight flight. The *Friendship* gives adequate stall warning and is exceptionally stable under all conditions; it has no spin tendencies and loses very little altitude during recovery. My immediate comment was that "it handles like a Piper Cub".

After several more standard air manoeuvres such as steep turns, slow speed flight, etc., we turned back to Schiphol Airport. During the high speed let-down, in the landing pattern, on the final approach and on touch-down, the *Friendship* handled beautifully. Due to the low approach and landing speed, unusual for such a high performance aircraft, we were able to come to a complete stop, after passing over a 50 ft. obstacle, in the short distance of 1,600 ft.

The airplane is so simple to fly, easy to handle and forgiving that the only potential danger might be a pilot's tendency to become careless, which however one does not expect an airline pilot to be anyway.

The pneumatic system provides a positive and fast gear retraction which I found to be very reassuring for single engine go-arounds during "missed approach" practice.

I have also flown in the second flying prototype which started its CAA certification tests in February 1957. It has a slightly longer fuselage, is pressurized, and has a completely finished interior. I was interested in seeing what the *Friendship* had to offer the passenger. Well, I found that the interior design of varying pastel colors gives the impression of a cabin much larger than it actually is. The high wing configuration offers all passengers unrestricted air to ground visibility. The lack of vibration resulting from the use of Rolls-Royce *Dart* turboprop engines, made the flight one of my most pleasant experiences in the passenger compartment of an airplane.

To sum up briefly, I would say that the *Friendship's* ground and air visibility, speed, stability, short field landing and take-off performance and safety features throughout should give the type a definite place in the transport aircraft family of the future.

The Lockheed Electra

A Typical Modern Short and Medium-Haul Airliner

By mid-February 1957 no fewer than 132 Lockheed *Electra* short and medium-haul aircraft had been ordered by eight U.S. and European airlines: 35 by American Airlines, 40 by Eastern, 9 by Braniff, 23 by National, 12 by K.L.M., 9 by Western, 2 by Braathens, 2 by Loftleidir. In addition, one aircraft (No. 1 or No. 133) will be delivered to the Allison Division of General Motors, manufacturers of the turboprops for the *Electra*.

The first aircraft of the new type will make their appearance on U.S. airports from August 1958 and on European airports from September 1959 onwards. The first of the batch—it would be misleading to speak of a prototype, as production is already under way—is scheduled to make its first flight in the Spring of 1958, and by the Summer of that year five *Electras* will be under test.

What is it that has induced the airlines to order this particular aircraft in such large numbers—and "off the drawing board"? This question was answered by *C. R. Smith*, President of American Airlines, last December as follows:

"During the past three years it has been necessary for us to make some basic decisions about the purchase of new aircraft, decisions which will fix the general composition of the American Airlines fleet for many years . . . It became rather obvious that we would not be able to do without the turbojet machine, for in the area of long distance, nonstop operation, at high altitude, no other airplane with which we are familiar today can compete with the turbojet . . . This led to the later purchase of the Boeing 707 . . .

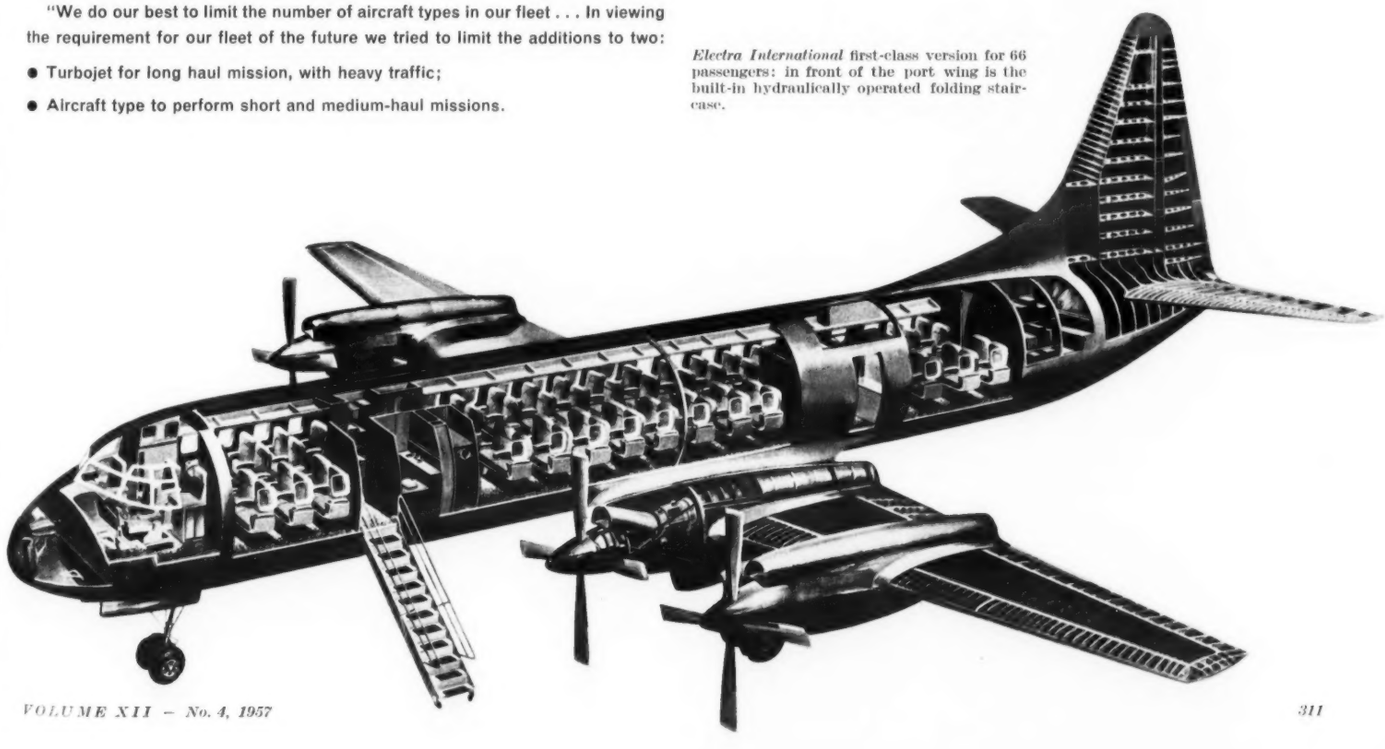
"We do our best to limit the number of aircraft types in our fleet . . . In viewing the requirement for our fleet of the future we tried to limit the additions to two:

- Turbojet for long haul mission, with heavy traffic;
- Aircraft type to perform short and medium-haul missions.

"We developed the following specification for the second airplane: *First*, good block speed for the short and middle distance runs; *second*, not be too sensitive to low altitude operation, nor should it require any unusual technique in the approach and landing pattern, for this airplane would be used on some schedules with many landings and take-offs, under all-weather conditions; *third*, must be able to operate from airports with moderate runway lengths; *fourth*, should have reasonable fuel capacity, related to zero fuel and landing weights, for it would operate on some runs with multiple stops, and we would not want to refuel too often . . .

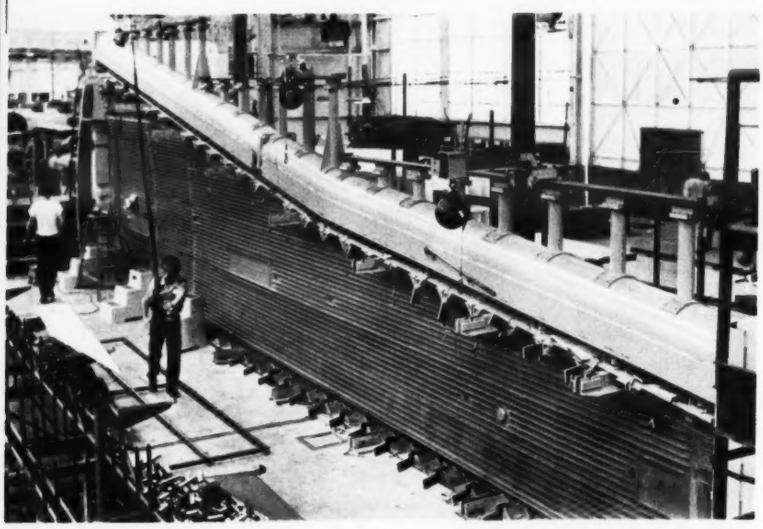
"So we came . . . to the conclusion that this was the proper area for a turboprop transport . . . We did not come out and ask Lockheed to build the airplane for us. We submitted the specification to several of the leading aircraft manufacturers, and asked them for a design, a specification and a price. Lockheed won the competition and got the order, and for good reason: . . . (they) showed the best concept. . . . believed, as did we, that this was a logical airplane . . . (and) expressed a confidence that the airplane could be sold in quantity . . . (Finally) Lockheed has an excellent reputation for building good machines."

C. R. Smith's remarks reveal that the time is past when the airlines had to be content with the equipment offered them and to "grow" with it. Today, operators demand that every aircraft should exactly meet the specifications they prepare on the basis of market surveys. Only if several large companies arrive at the same technical requirements, or can be persuaded by the designers that a new design is a timely and logical step forward, has this design a chance of capturing a wide market.



Electra International first-class version for 66 passengers: in front of the port wing is the built-in hydraulically operated folding staircase.

The flight station: in front of each control column are the usual flight and navigation instruments and – covered by square metal plates – the two scopes for the RCA radar. In the centre portion of the instrument panel are the engine instruments, in particular the four turbine inlet temperature indicators (left half, top), the torquemeters (centre) and the tachometers. The consoles on either side each contain four power levers and the hand wheels for elevator tab control, also rudder and aileron tab controls and various radio equipment controls. Numerous other switches and controls are arranged overhead: far left, the three-armed hand wheel for nose steering.



The integrally stiffened wing of the first *Electra* (upper side of port wing) takes shape.

Full-size mockup of the main cabin for the 66-seat domestic version. The central aisle is 26 ins. wide; the lounge is in the far rear.

Air transport vistas

All this is true of the Lockheed *Electra*. Other advantages of the new aircraft have been described by T. F. Bergmann, Lockheed Export Sales Manager, as follows:

- *Range flexibility:* stages of 100 to 2,600 nautical miles can be flown with high economy, hence suitability for airlines with normal or unusual route networks.
- *High block speed and minimum ground time:* hence high cruising speed (352 knots), provision for carry-on luggage, fast refuelling, large fuel capacity, built-in passenger stairs, etc.
- *Extensive independence of altitude and weather; ability to use small airports.*
- *Payload balance:* on the one hand the aircraft should not be so large that it could not break even with a low load factor in low density areas (normal seating capacity 66 passengers; large holds for extra cargo); on the other hand it must allow for "growth" (versions for 85, 88 or 91 passengers).
- *Low fuel costs:* thanks to the economy of turbine fuel and the *Electra*'s clean aerodynamic lines, fuel costs are roughly 30% lower than in comparable piston-engine aircraft.

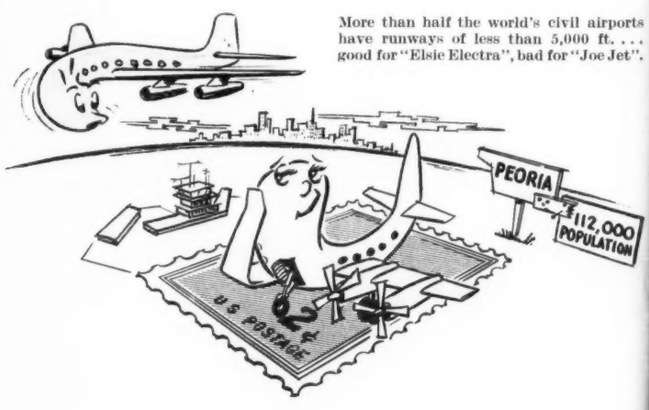
The *Electra* has a particularly wide fuselage (inside diameter 128 ins.) which permits either four-abreast or five-abreast seating and a central aisle of either 26 or 17 ins. It is offered in two main versions:

- *Domestic version, 188A-08-03:* with six-seat lounge in the rear and two toilets (starboard only), for 66 or 85 passengers (plus 6). Crew 3, plus 2 hostesses.
- *International version, 188A-08-04:* no lounge, but four toilets, for 44, 65, 66 or 88 passengers. Crew 4, plus 2 hostesses.

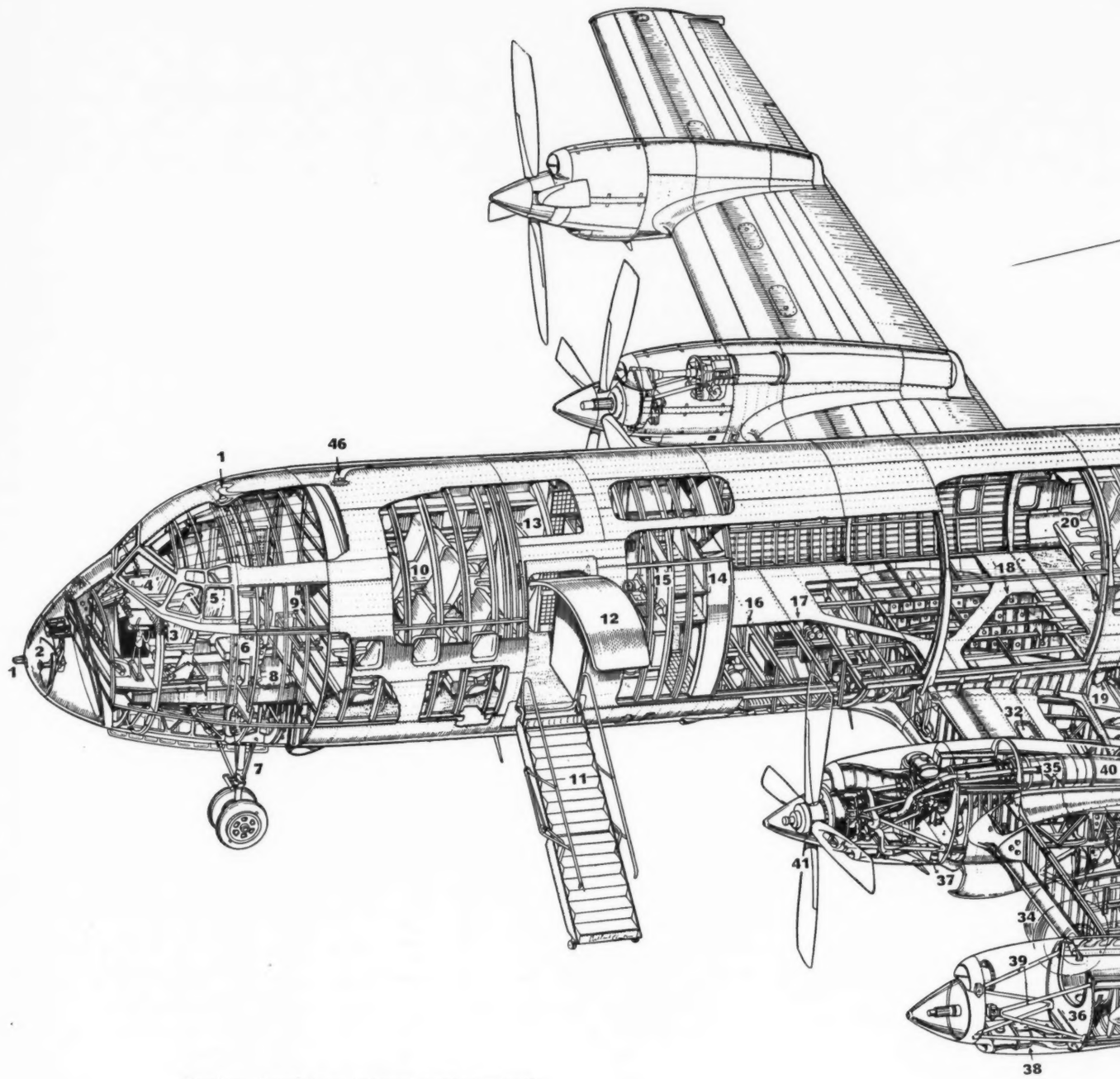
All main and sub-versions have four Allison 501-D13 (T56) turbo-props of 3,800 e.h.p. each. Later the slightly more powerful 501-D15 (4,050 e.h.p.) can be fitted. The structural principles used in the *Electra* were described in *Interavia* No. 7, 1956; a survey of all major technical data is also given on the following two double pages.

*

Production of the new aircraft is in full swing at Lockheed's Burbank plant. More than half of the 45,000 jigs and special tools required for the *Electra* were in place by mid-February 1957, and the number of parts manufactured had already reached more than a thousand per week. The Allison T56 engines, which are also to power the Lockheed C-130A *Hercules* military transport, are undergoing a stringent operational testing. By mid-February the U.S. Air Force had received fifty C-130s (with 200 engines); by the beginning of 1959 roughly a thousand Allison engines will be in squadron service and will have completed nearly a million running hours. In addition, Lockheed plans to submit a civil version of the T56 to a 1,000-hour endurance test aboard a modified *Super Constellation* in July this year, after which the company, along with Allison, will apply for C.A.A. certification of the engine and its Aeroproducts propeller.

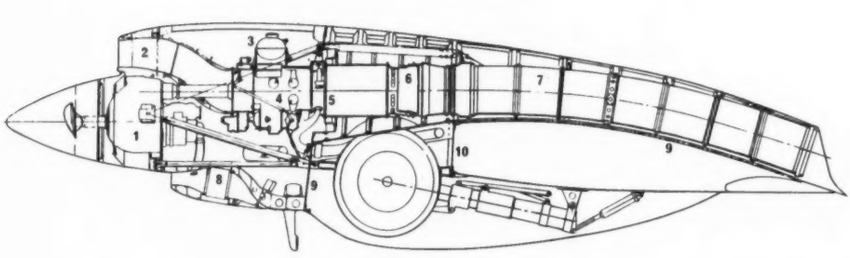


More than half the world's civil airports have runways of less than 5,000 ft. . . . good for "Elsie Electra", bad for "Joe Jet".

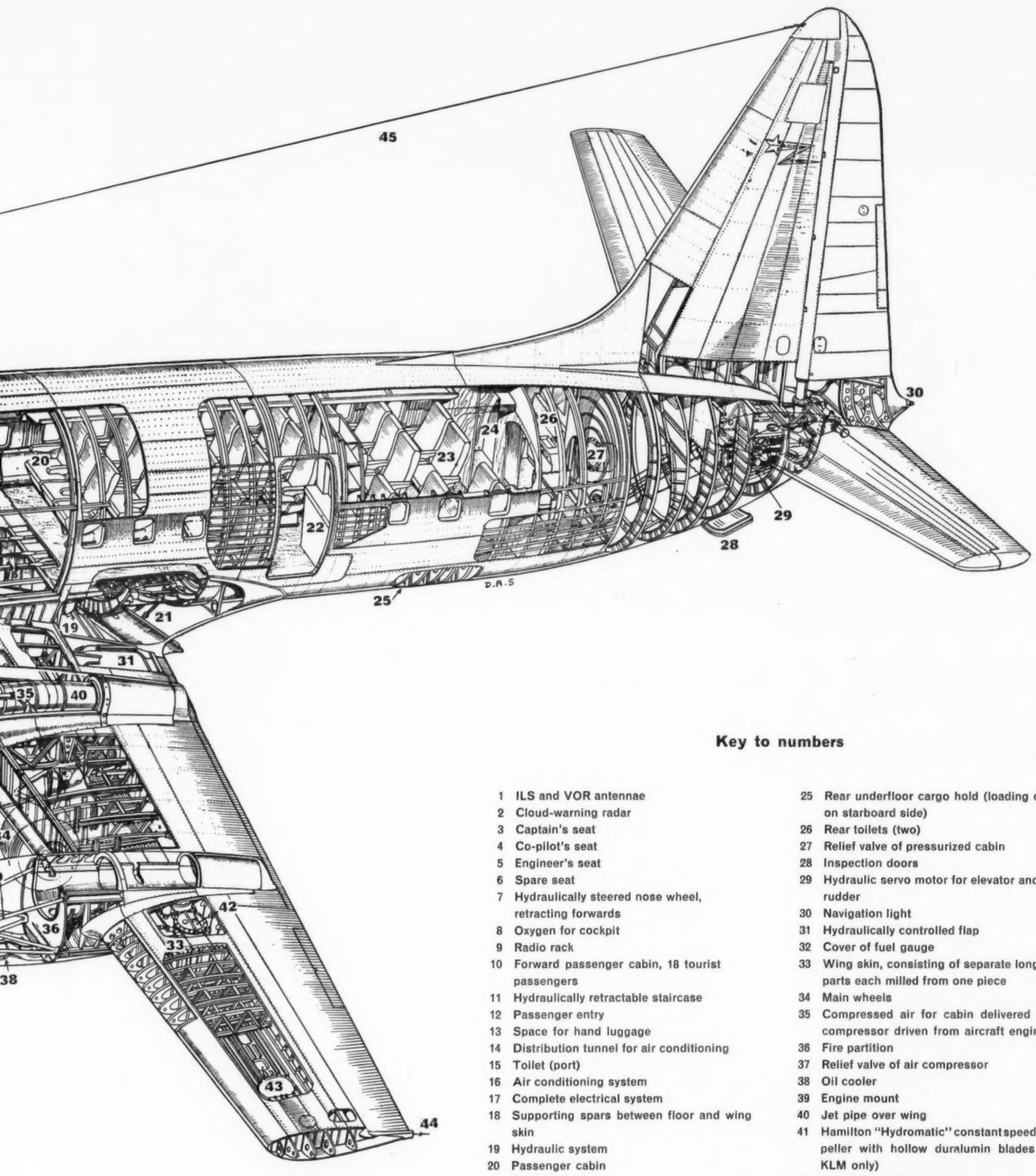


Section through an inboard engine nacelle

1	Gear box	6	Turbine
2	Air intake	7	Tailpipe
3	Oil tank	8	Oil cooler
4	Compressor	9	Firewall
5	Fire seal	10	Front spar

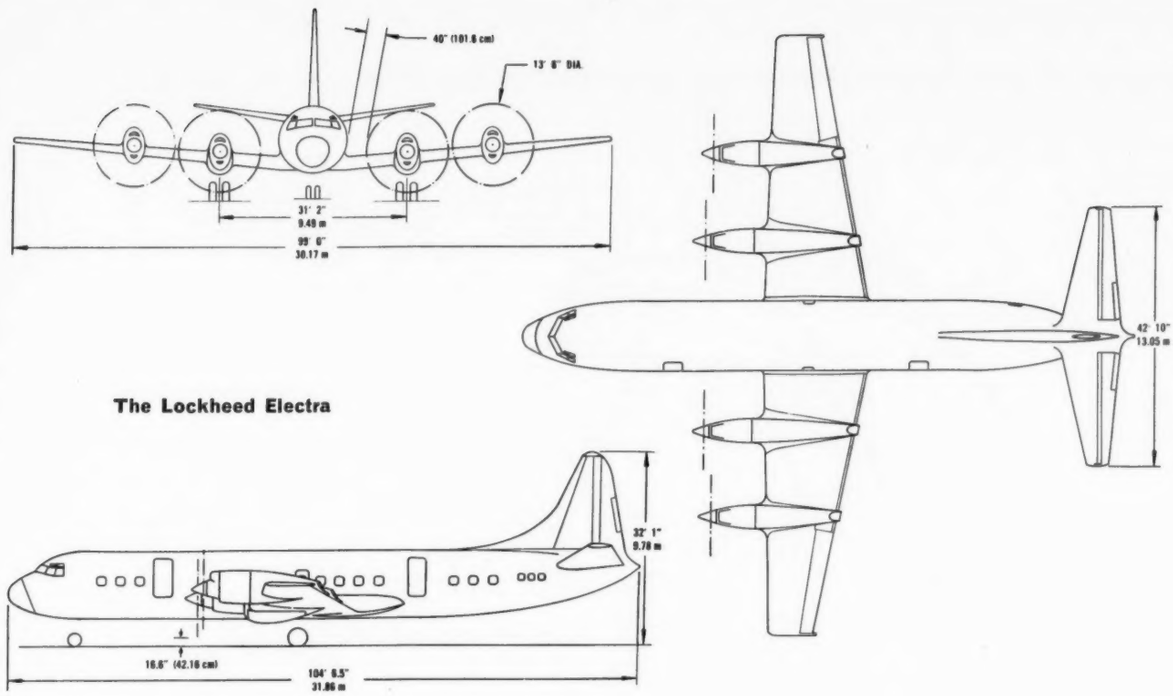


Structure of the four-turboprop Lockheed Electra (mixed-class international version)



Key to numbers

1 ILS and VOR antennae
2 Cloud-warning radar
3 Captain's seat
4 Co-pilot's seat
5 Engineer's seat
6 Spare seat
7 Hydraulically steered nose wheel, retracting forwards
8 Oxygen for cockpit
9 Radio rack
10 Forward passenger cabin, 18 tourist passengers
11 Hydraulically retractable staircase
12 Passenger entry
13 Space for hand luggage
14 Distribution tunnel for air conditioning
15 Toilet (port)
16 Air conditioning system
17 Complete electrical system
18 Supporting spars between floor and wing skin
19 Hydraulic system
20 Passenger cabin
21 Air brakes (three)
22 Pantry
23 Adjustable passenger seats
24 Service door
25 Rear underfloor cargo hold (loading doors on starboard side)
26 Rear toilets (two)
27 Relief valve of pressurized cabin
28 Inspection doors
29 Hydraulic servo motor for elevator and rudder
30 Navigation light
31 Hydraulically controlled flap
32 Cover of fuel gauge
33 Wing skin, consisting of separate long parts each milled from one piece
34 Main wheels
35 Compressed air for cabin delivered by a compressor driven from aircraft engine
36 Fire partition
37 Relief valve of air compressor
38 Oil cooler
39 Engine mount
40 Jet pipe over wing
41 Hamilton "Hydromatic" constant speed propeller with hollow duralumin blades (for KLM only)
42 Fire extinguishing tanks
43 Underwing inspection doors
44 Fuel dumping pipe
45 HF antenna
46 VHF antenna



The Lockheed Electra

Technical data for the 188A-08-03 version*

Dimensions

Span	99 ft.
Overall length	104 ft. 6.5 ins.
Height	32 ft. 1 in.
Tailplane span	42 ft. 10 ins.
Undercarriage track	31 ft. 2 ins.
Wing area	1,300 sq. ft.
Aspect ratio	7.5
Wing dihedral	6 °
Main cabin floor area	707 sq. ft.
Hand luggage rack in main cabin	119 cu. ft.
Underfloor baggage hold	190 cu. ft.
Forward cargo hold	64 cu. ft.
Rear cargo hold	263 cu. ft.

Weights

Wing		7,670 lbs.
Tail unit		1,927 lbs.
Fuselage		9,954 lbs.
Undercarriage		3,817 lbs.
Engine nacelles		4,417 lbs.
Turboprop engines		13,733 lbs.
Fixed airborne equipment		14,469 lbs.
Instruments	441 lbs.	
Controls	1,509 lbs.	
Hydraulic system	483 lbs.	
Electrical system	1,836 lbs.	
Electronic equipment	1,274 lbs.	
Cabin equipment	5,978 lbs.	
Air conditioning system	2,064 lbs.	
De-icing system	884 lbs.	
Weight equipped		55,993 lbs.
Operating useful load[1]		2,875 lbs.
Crew (5) + crew baggage	895 lbs.	
Passenger and service equipment	1,461 lbs.	
System fuel and oil	519 lbs.	
Operating weight empty		58,868 lbs.
Payload		18,907 lbs.
66 passengers	10,890 lbs.	
Baggage	2,640 lbs.	
Cargo	5,377 lbs.	
Max. dry weight		77,775 lbs.
Reserve fuel		7,240 lbs.
Landing weight		85,015 lbs.
Stage fuel		21,685 lbs.
Take-off weight		106,700 lbs.

Power plant

Four Allison 501-D13

Take-off rating per engine (at 13,820 r.p.m.)	3,750 e. h. p.
Max. continuous power (at 13,820 r. p. m.)	3,375 e. h. p.
Economic cruising power (at 13,820 r. p. m.)	2,025 e. h. p.
Specific fuel consumption at economic cruising power	0.665 lbs./e.h.p./hr

Aeroproducts four-blade propellers of 13 ft. 6 ins. diameter

Fuel in four integral tanks

Two tanks in inner wings, each for	1,090 U.S. gals.
Two tanks in outer wings, each for	1,590 U.S. gals.
Total	5,360 U.S. gals.

Performance

Cruising speed at 22,000 ft. for 85,500 lbs, gross weight[2]	352 knots
Design max. range in high-altitude cruise for 106,700 lbs. gross weight with 28,925 lbs. stage fuel and 7,240 lbs. reserve fuel[3]	1,980 naut. miles
CAA take-off field length at sea level, under standard conditions (CAR 40.72) for 106,700 lbs. take-off weight[3]	5,250 ft.
CAA landing field length at sea level, under standard conditions (CAR 40.77) for 85,500 lbs. landing weight[3]	4,950 ft.
CAA rate of climb immediately after take-off at sea level, under standard conditions (CAR 4b.120b) but with automatic feathering, for 113,000 lbs. take-off weight[4]	730 ft./min.

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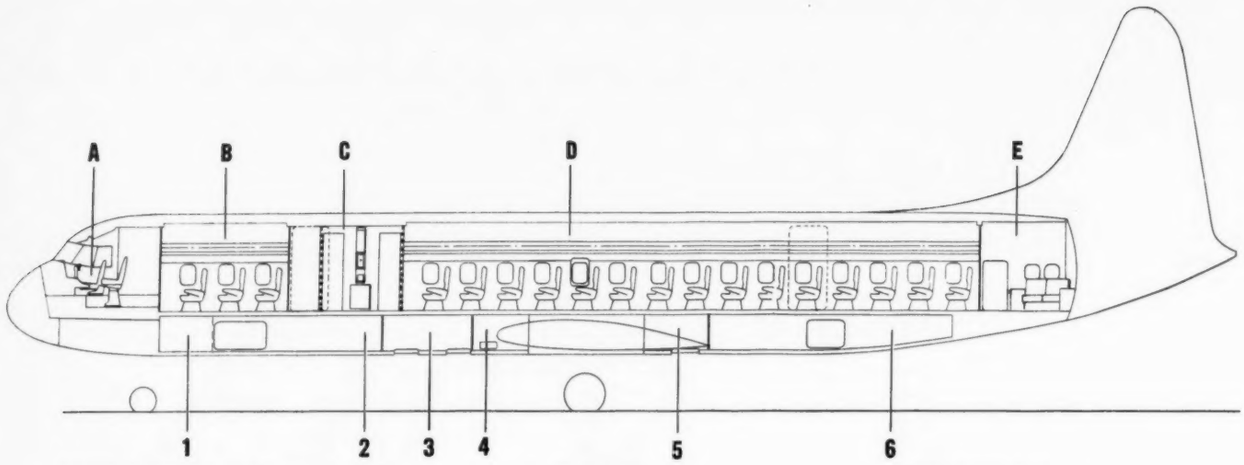
* In the type designation 188A refers to the airframe series, 08 the power plant, 03 the interior layout (domestic).

[1] The following weights apply for a range of 1,600 nautical miles with a head wind of 43 knots.

[2] Guaranteed to within ± 3%.

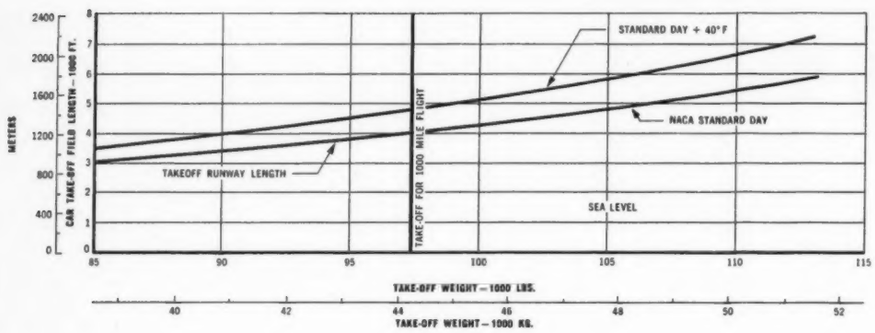
[3] Guaranteed to within ± 5%.

[4] Guaranteed to within ± 10%.

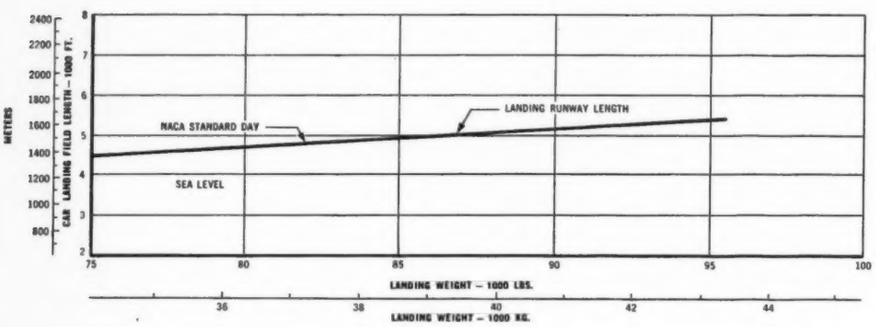


Layout of 66-seat domestic version (188A-08-03)

- A Flight station
- B Forward passenger cabin
- C Entrance; two hand luggage racks; two toilets; one wardrobe
- D Main cabin
- E Six-seat lounge
- 1 Forward cargo hold
- 2 Baggage hold
- 3 Air-conditioning system
- 4 Electrical system
- 5 Hydraulic system
- 6 Rear cargo hold

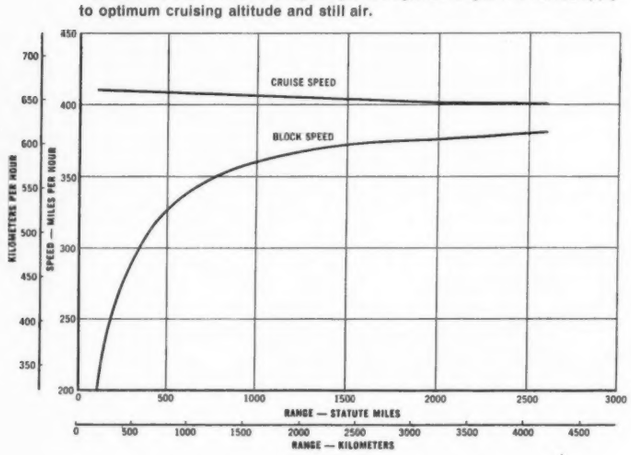

METERS
CAR TAKE-OFF FIELD LENGTH – 1000 FT.
STANDARD DAY + 40° F
NACA STANDARD DAY
TAKEOFF RUNWAY LENGTH
TAKE-OFF FOR 1000 MILE FLIGHT
SEA LEVEL
TAKE-OFF WEIGHT – 1000 LBS.
TAKE-OFF WEIGHT – 1000 KG.

CAR take-off field length plotted against take-off weight. For a take-off weight of 97,432 lbs. (heavy vertical line) and on a **NACA** standard day, sea level take-off runway length is 4,080 ft.; for the same weight but under standard conditions + 22°C (standard day + 40°F) 4,900 ft. For a take-off weight of 113,000 lbs. the figures are 5,820 ft. and 7,240 ft. respectively.

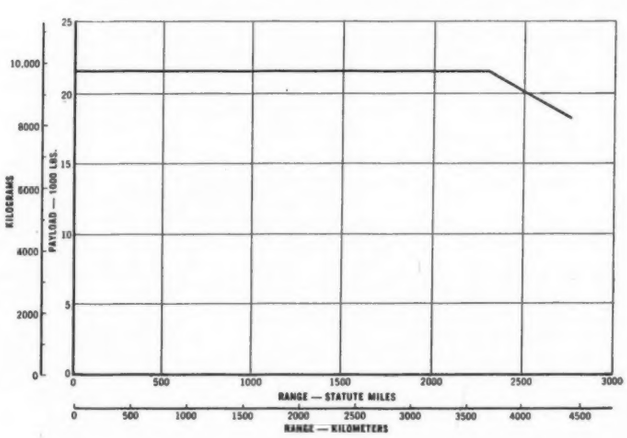


CAR landing field length plotted against landing weight, without allowance for reverse thrust propellers. The graph applies to standard conditions at sea level and reveals, for example, a landing field length of 4,920 ft. for the normal landing weight of 85,015 lbs.

The *Electra's* cruise and block speed plotted against range. The curves apply to optimum cruising altitude and still air.



The *Electra's* transport capacity in still air and with a fuel reserve of 2½ hours.



Towards the Supersonic Airliner

Britain's Views

Supersonic airliners are bound to come sometime. This is regarded as fact in the United States and Britain, and no doubt also elsewhere. In America, at least one major aircraft manufacturer, Lockheed Aircraft Corporation, have decided to refrain from participating in the present long-range subsonic jet transport competition in order to concentrate on the production of a short-to-medium range turboprop aircraft for the immediate future, and to work on the development of a supersonic airliner for service later on.

In Britain, a group of aircraft firms, in cooperation with the Government's research establishments and the two nationalised airline corporations, have set up a committee which is endeavouring to find the answers to such questions as—when will the supersonic airliner be needed? What form should it have? At what speed and over what distances should it travel? As Britain's aircraft industry is not a competitor in the long-range subsonic jet race, it has been possible to obtain a rough outline of the thinking behind her present supersonic transport plans.

The big subsonic jets such as the Boeing 707 and the Douglas DC-8 are booked for a life of at least ten years, beginning in 1959–60, and therefore there was little point, at this belated stage, in any British manufacturer attempting to build a competitor. This reasoning was the cause of the speedy demise of the de Havilland 118 North Atlantic-cum-medium-haul project which had more ministerial enthusiasm than airline interest behind it. The next logical step in the big transport field would be to go supersonic in the 1970's. In order to do so, undoubtedly the most costly and complex civil development programme ever to be undertaken will be required. It will take about four times as much design effort as for a conventional transport like the *Britannia*, and it will mean a complete change of outlook for the airlines who propose to operate such machines.

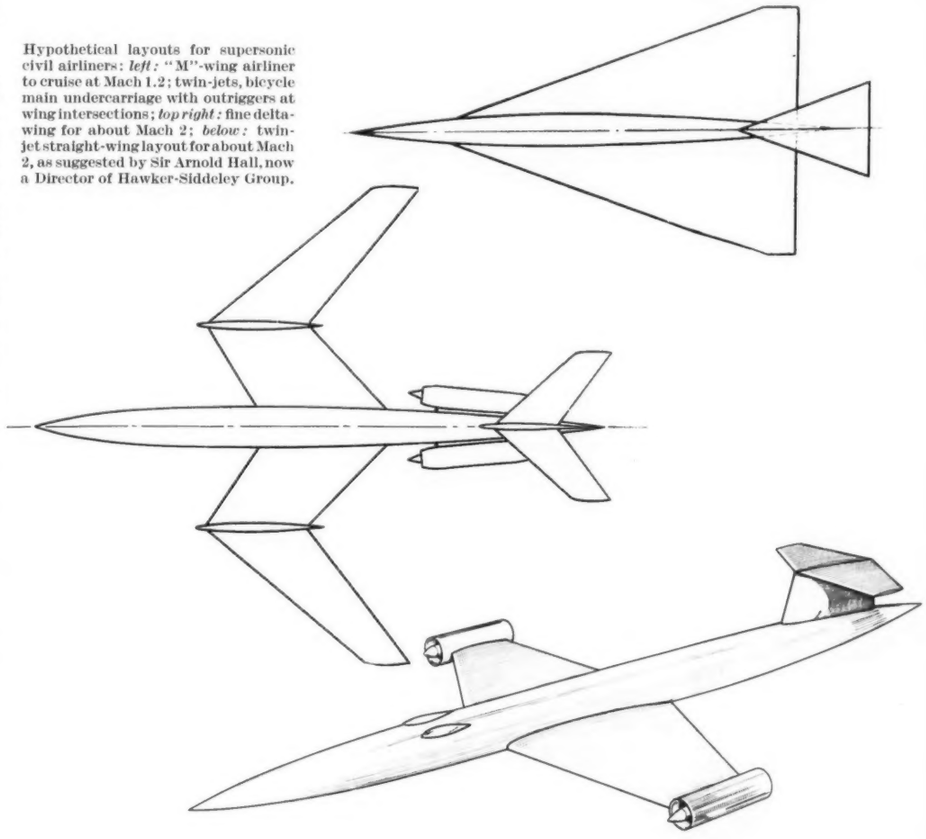
As soon as news of the work of the committee leaked out in Britain, daily newspapers produced glowing reports that seven British aircraft firms had joined forces to build a super-shining aeroplane. This is a basic misconception. The "British Supersonic Consortium", as it has become generally known, has been formed by Avro, Bristols, de Havilland, Rolls-Royce, Vickers, Shorts, Handley Page, B.E.A., B.O.A.C., and the Royal Aircraft Establishment (but not English Electric and Fairey who have most of the practical experience of supersonic flight in Britain) to study various aeroplane configurations and decide what sizes and speeds of aeroplane will be workable and to which both the Government and the industry can be committed.

In view of the steady reduction in the size and number of military contracts and the growing emphasis on the civil export market, the resulting official design competitions—which will probably emerge in 1959—will be the toughest the industry has ever fought. While the committee members realize the necessity for joint consultation in the early stages, none are in any doubt that one firm and one chief designer must finally get the individual prime contracts.

For the first time the airlines are not in a position to specify exactly what they would like, apart from protesting when too high approach speeds are mentioned. While the Corporations have worked out various sets of cost figures for potential X-seater aircraft flying at Mach Y, they are entirely in the hands of the designers when it comes down to actual consideration of a practical airliner. It will be the designers who, after completing their mathematics, will tell them that they can have one of three possibilities only, with a fixed range, payload, and speed in each case.

On one aspect all firms seem agreed, namely, that the operating costs of proposed supersonic transports will be 40 to 50 percent higher than of aircraft now being prepared for service. Thus the supersonic transport will be essentially a luxury vehicle with a very high fare. It would seem that present deliberations on a three-tier fare structure may end up with a four-tier set-up, the fourth tier being unpleasantly expensive.

The "Supersonic Consortium" have narrowed their general deliberations down to three speed categories, Mach 1.2, Mach 1.5 and Mach 1.8; ranges in each case would be either 1,500 miles or 3,000 miles, with a capacity for around 100 passengers. It is quite clear from the outset that with present



Hypothetical layouts for supersonic civil airliners: *left:* "M"-wing airliner to cruise at Mach 1.2; twin-jets, bicycle main undercarriage with outriggers at wing intersections; *top right:* fine delta-wing for about Mach 2; *below:* twin-jet straight-wing layout for about Mach 2, as suggested by Sir Arnold Hall, now a Director of Hawker-Siddeley Group.

What the Designers Say

Interavia's London Editor last month asked of Britain's leading aircraft designers what they thought of the prospects of developing a supersonic commercial airliner. Here are their answers.

English Electric Company: One most important point to settle is the design speed of a supersonic airliner project. Increase in Mach number well beyond 2 may introduce too many temperature and other problems for the comfort, economy or safety of such an aircraft, and it therefore seems that an initial project should aim for a Mach number of about 2. Mach 2 is a considerable increase over the speed of airliners of the coming jet generation, and that fact provides good reason for awaiting the opportune moment before deciding finally the design of a supersonic airliner.

There is a discontinuity at the speed of sound which contravenes the general transport requirements for progressively higher speeds over long distances. The operational experience from a short haul supersonic airliner might be useful, but the economic value would be very questionable. It might, therefore, pay to wait until sufficient military service and design experience has accumulated to make possible a more economical design.

A. E. Russell, C. B. E., D. Sc., F. R. Ae. S., F. I. Ae. S., Director and Chief Engineer of Bristol Aircraft Limited: It is not so long ago since "first line fighter aircraft" caused a sensation by producing supersonic bangs. This they were able to manage by losing a lot of height. Now, there are some genuinely supersonic fighters entering service. This progress seems to encourage some people to contemplate a supersonic trans-Atlantic civil airliner.

Before this possibility passes out of the realms of contemplation, a great deal of research and analysis will have to be carried out. Even if it can be established that the technical problems can be solved, it will still need to be justified as an economic proposition.

At this stage no-one knows the answers to these questions, but it is not unreasonable that someone should be taking steps to provide data from which a fair assessment may be made.

R. L. Lickley, B. Sc., D. I. C., M. I. Mech. E., F. R. Ae. S., Director and Chief Engineer, Fairey Aviation Co. Limited: The supersonic transport is sure to come, but it will not be much good unless it cruises in the speed range Mach 1.5 to Mach 1.8. It must have this high supersonic speed to make people pay what will inevitably be a very high fare. It will never be as cheap nor as efficient as a fully developed jet transport flying at just under supersonic speed.

David Keith-Lucas, B. A., M. I. Mech. E., F. R. Ae. S., Director and Chief Designer, Short Brothers and Harland Limited: We probably know enough now to build supersonic civil aircraft which would work. We do not yet know how to achieve the lowest operating costs. We cannot even be sure whether to aim at a speed of Mach 1.3 with swept (possibly "M" or "W") wings or at Mach 2 with thin straight wings.

My guess is that ultimately Mach 2 and above will prove more economical than lower supersonic speeds, but the engineering problems are formidable and will take many years to master. In the meantime the best economy will be achieved around Mach 1.3.

Within the foreseeable future the operating costs are likely to be 50% higher than for subsonic aircraft but supersonic aircraft will probably be operated nevertheless mostly for reasons of prestige.

Perhaps the brightest future for civil aviation lies in reducing costs rather than in raising speed. This will attract an ever growing proportion of the travelling public and freight. I wonder how many more *Viscounts* B. E. A. would need if the London-Paris fare could be cut by 20%. Such a cut would, surely, attract more passengers than an increase of even 200% in the speed . . .

C. F. Joy, F. R. Ae. S., Chief Designer, Handley Page Limited: The design of a supersonic civil transport is an ambitious project, not only because of the technical problems involved but also the probable demand for new conceptions of airworthiness and operational techniques.

Supersonic aircraft will be more costly to operate than current types. Ultimately, it will be the travelling public which decides to what extent the additional passenger appeal of high-speed flight can be reconciled with higher operating costs. Increases from high subsonic to low supersonic speeds may raise direct operating costs by 40 to 50%; further increases to about Mach 2 may cost more. If the first step is worth while then, presumably, so is the second. Should they be combined? The airline operator is best qualified to answer these questions and his part in deciding the best cruising speed is of vital importance.

Aerodynamic design will require an immense amount of wind tunnel and other research. It appears, however, that design of an aircraft cruising between Mach 1.5 and 2.0 will be no more difficult, and probably even easier, than that of one cruising in the partly transonic range of M = 1.0 to 1.5.

Structural design is not necessarily difficult for speeds up to M = 2 as kinetic heating does not rule out conventional materials. In fact, the supersonic aircraft structure may well be simpler than that of the high subsonic transport with high aspect-ratio highly-swept wings.

Sir Roy Dobson, Kt., C. B. E., Hon. F. R. Ae. S., Managing Director of A. V. Roe and Co. Limited: Healthy competition should result from the fact that seven aircraft firms will compete for orders to build the aircraft. In my view, Britain can jump ahead of present American jet airliners by going in for faster passenger machines. It may be desirable to issue two specifications—one for an aircraft designed to fly at about 800 m. p. h. and the other at about 1,200 m. p. h. In fact, I hope that the Joint Committee will propose two types to operate at these speeds. However if you must fly supersonically it will cost a lot more and may in fact double present operating costs. There is no doubt that supersonic air transport will come, but tremendous research will be necessary.

E. E. Marshall, Assistant Chief Designer (Projects), Vickers-Armstrongs (Aircraft) Limited: It is clearly the ambition of the British aircraft industry to win as much as possible of the market for a long range airliner, and how to achieve this is the problem that a group of British aircraft designers is combining with the R. A. E. to solve.

First of all—what will the operator want in order to convince himself that he should spend money to replace his existing fleet? Clearly he will want a greater speed, which means supersonic speed as the aircraft to be replaced will be high subsonic. He will also want competitive operating costs, together with better passenger comfort and better maintenance.

The first generation of supersonic civil aeroplanes may come into service in the late 1960s. The cruising speeds at which they will operate will favour high utilisation with one or more round trips per day on routes such as London-New York. At this speed there would be no serious high temperature problems either for the structure or for the air conditioning for the cabin.

What the aeroplane would look like it is not possible to say at this early stage—but present day knowledge would indicate that, in order to achieve the economic performance essential to make it attractive to an airline, it will seat around 200 passengers.

knowledge and foreseeable engines, a non-stop North Atlantic supersonic airliner with any reasonable payload is out of the question. R.F. Creasy, of English Electric, in his recent lecture on problems of high speed flight before the Royal Aeronautical Society stated, "long ranges, which have already proved possible at supersonic speeds, are quite out of the question at transonic speeds. This is due to the decrease in L/D (or fuel energy) of practical configurations. At higher speeds, increase in jet engine efficiency results in a progressive recovery in range."

Several members of the Committee favour going to between Mach 1.5 and 1.8 on a stage length of around 1,500—2,000 miles and would like to look at Mach 2 or 2.5. The interest at the top end of the scale, where engines operate at high propulsive and thermal efficiency, is tempered, however, by the tremendous problem of the kinetic heat rise so that stainless steel and titanium sandwich would have to be used.

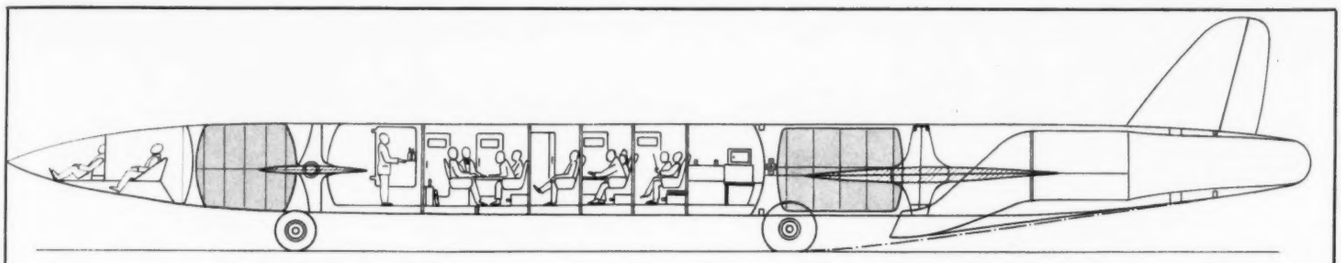
The fundamental problem with all the designs is how to carry the fuel and the power to give the performances that go with advanced aerodynamic shapes. A 100-seat aeroplane, for instance, which is designed to cruise at Mach 0.9 with a lift/drag ratio of 18, could happily exist on four 18,000 lb. turbojets. If the speed is put up to Mach 1.8, with a helpful lift/drag ratio of 9, the power needed would be of the order of eight 18,000 lb. thrust turbojets. As far as L/D goes, Sir Arnold Hall in his Wright lecture in Washington on December 17th last year said, "My impression is that no easy way has yet emerged for obtaining medium-supersonic (Mach 1.5 to Mach 3) lift/drag ratios greatly exceeding 6, and the virtues of new shapes may be found more in their structure weight than in their aerodynamics."

The wing designs being considered are fairly conventional, namely, delta and sharply swept (including tailfirst) in the Mach 1.5 and 1.8 categories and a choice between straight, swept and fine delta at about Mach 2. As one top executive put it, "we have just run out of aerodynamic gimmicks and have to face the facts of life."

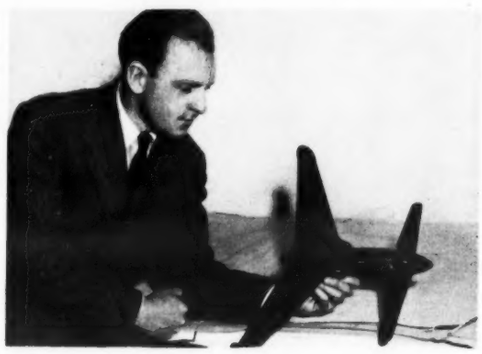
Around Mach 1.1 and 1.2, however, great controversy is going on over the "M" and "W" wings.

The M-wing, combined with area rule, is basically intended to allow high L/D ratios to be maintained in the critical phase of Mach 0.85 to Mach 1.2 and give structural gains due to its aero-elastic properties. The design of such a wing is very critical, and it is thought in some quarters that the tremendous amount of mathematical and wind tunnel research that would be involved might be better spent on attempts higher up the Mach scale.

Other major problems which at present concern the manufacturers and the airlines are noise, pressure cabin structures, fatigue



One of Britain's pioneers in the study of supersonic civil aircraft was George H. Miles of the former Miles Aircraft Ltd., now with F. G. Miles Ltd., of Shoreham-by-Sea. At the end of 1941 he devised the *Libellula* type of tandem-wing aircraft. In 1943 he began work, with Government support, on the M.52 1,000-m. p. h. civil aircraft of conventional layout, but in 1946 the Government development contract was cancelled. In the same year he combined the results of both studies in the design of a supersonic (Mach 1.2) twenty-passenger jet airliner of tandem-wing configuration, but construction never started. Main figures for the design were: *Front wing:* span, 45 ft. (13.7 m); area, 250 sq. ft. (23.2 m²); *rear wing:* span, 73 ft. (22.3 m); area, 880 sq. ft. (81.8 m²); *length*, 99 ft. (30.2 m); maximum take-off weight, 79,870 lbs. (36,230 kg). Power plant apparently was to consist of a group of high-power turbojets, in the fuselage rear with an under-belly air intake.



George H. Miles with a model of the M.63 B twin-jet *Libellula*-type mail carrier design of 1946 (left) and the Miles Mach 1.2 twenty-passenger civil airliner project of 1946.

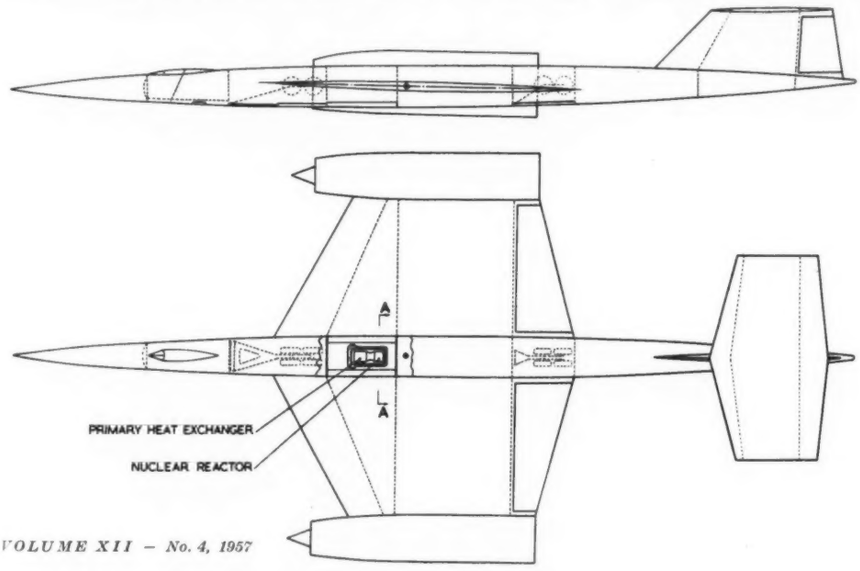
in various types of new alloys, internal systems, vertical take-off, jet deflection, and the jet flap. In addition there is the question of how to avoid dangerous supersonic bangs over land with aircraft which cruise at supersonic speeds.

Where ground noise is concerned, manufacturers are unlikely to accept high thrust and weight penalties on "delicate" installations by the inclusion of silencers, and the actual volume of noise (due to the power required) will be very great. Fatigue will need a great deal of study and designers do not seem certain whether to aim for a "fail-safe" or a "safe-life" pressure cabin, although a true "fail safe" would probably be called for by the certifying authority.

The jet flap is in favour, ahead of the concept of VTO engine batteries, which are not likely to be used much before Mach 2. At present the flaw in the jet flap installation is piping extremely hot gases over long distances, and the provision of a high strength slot in the trailing edge of an ultra-thin wing. An interim solution will, of course, be the employment of flap blowing. Jet deflection is likely to be another more reasonable solution than either VTO engines or the jet flap for some time to come.

While most designers would like to see engines with even higher power weight ratios and better specifics, they admit that the present range of high compression engines, such as *Olympus* and *Avon,* will suit them up to Mach 1.8 if they can get the aerodynamics right. From Mach 1.8 onwards, compression ratios will have to go down to about 7 to cope with ram effect. Chemical fuels would give a percentage reduction in consumption but not sufficient to allow any appreciable increase in payload or range, and the cost would be prohibitive.

One further item looms on the horizon which may alter the situation: atomic power. Atomic power units such as small breeder reactors have a major disadvantage in the high weight of shielding required. If some new method of shielding can be found, as seems likely, then atom powered supersonic civil aircraft will have to be seriously considered before 1970. Compared with the weight of fuel and engines to be carried on a Mach 1.8 aircraft, the weight of a small reactor and its shielding begins to look much more reasonable.



The ultimate solution: layout of a nuclear-powered twin-jet supersonic aircraft, as suggested by E. P. Hawthorne of The Hawker Siddeley Nuclear Power Co. Ltd. Dimensions and weight of such an aircraft would be awe-inspiring, but range would be practically unlimited.

The Allée Verte Heliport, Brussels.

Stalking from Brussels to Paris

The paradox of it all is that one of the newest forms of civil air transport brings back to you all the joys of the earliest days of flying. Travelling from Brussels to Paris on the inaugural flight of *Sabena Belgian World Airlines'* helicopter service was like walking on giant stilts across country, forests, rivers and canals. Once again we could discover the incredible amount of rubbish people hoard in their backyards. Once again we watched a cyclist peering skyward until he pitched into the ditch beside the road . . . a cow crashing into its stable without first opening the door . . . two horses running around in wild circles . . . swarms of frightened black and white birds rising from the fields and woods. Happy times are here again—including some of the noise and vibration (but the seating comfort is much better).

The atmosphere on that Sunday morning, March 3rd, was of course unique. Sabena's whole fleet of eight Sikorsky S-58 ten-passenger helicopters took off from the Allée Verte city-centre heliport in Brussels, loaded with government and airline dignitaries and aviation journalists from a variety of countries, and flew in "V" formation at a height of about 1,000 ft. above the sunny countryside to Issy-les-Moulineaux ("Ici les Moulinets!") heliport *near* the heart of Paris. Travelling distance was 175 miles, travelling time 2 hours—much slower than by fixed-wing aircraft from airport-to-airport, but timesaving nevertheless because no tedious city-to-airport journeys were required. And much more amusing.

At the new Paris heliport the guests were received by the French authorities, welcoming speeches were made by French and Belgian Government department, airport and airline heads. Louis Couhé, Chairman of the Paris Airport Authority, estimated that in due course the Paris heliport will handle about 1,000,000 passengers per annum. These optimistic prophesies were followed by a general assault on the buffet luncheon, spearheaded by dozens of the elegant French ladies who apparently had been starving to death while awaiting the arrival of the helicopter cavalcade.

In the weeks since the official inauguration, Sabena has settled down to operating two helicopter schedules daily in each direction, in addition to its two daily Brussels-Paris fixed-wing flights. On April 15th the helicopter runs will be increased to five daily each way. The fare is the same for both fixed and rotary-wing schedules.

It is no secret that the helicopters available to commercial operation today, including the large ones like the S-58, are very expensive to buy, taking into account their limited carrying capacity, to operate and maintain. We therefore asked one of Sabena's executives whether the company was expecting to make money on its new rotary-wing schedules. "Well", he said, "that would be too much to anticipate. But with these new machines we are going at least to break even, whereas we were losing money with the older, smaller S-55's. However, while we were making a loss we were buying experience with our money, and we are buying even more experience with the S-58's. When bigger, more economic machines become available, we shall be the first to be able to make a profit in this new field and provide the public with a service which ultimately will greatly cut travelling time on short-range routes."

At any rate, if we had the choice of flying either aboard a conventional airliner or a helicopter over short distances in daytime, the helicopter would win hands down.

The helicopters leave. "Ours" was the one marked "L" and flew in the first position to the rear and right of the leader of the "Vee".

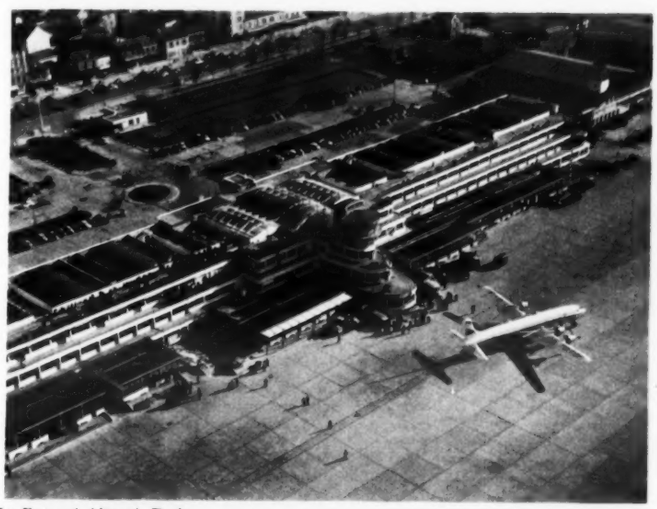
Peeping into other people's backyards.

Helicopter formation flying.

Bridges of Paris – Eiffel Tower in background.

More backyards – this one is on a grandiose scale.

Heliport at Place Balard, Issy-les-Moulineaux, Paris.



Le Bourget Airport, Paris.

Another of Sabena's S-58's lands at Issy.

Over the Arc de Triomphe.

Some of the notables who took part in the inaugural flight: *left to right:* M. Cot, Director-General of the Paris Airport Authority; M. W. Deswarte, Director-General of Sabena; M. E. Anseele, Belgium's Minister of Communications; M. A. Hanlot, Belgium's Commissioner-General for Tourism; M. A. Burgand, Cultural Attaché at the French Embassy in Brussels; M. Mouchez, France's Director-General of Air Bases; another traveller, not shown in the picture, was M. Gilbert Périer, Chairman of Sabena.

U.S. Air Power in the Cross-Fire of the Symington Committee

Which is the stronger? Has the Red Air Force outpaced the U.S. Air Force, or does the United States still have a sufficient air power superiority to deter an aggressor? This is the question to which a special subcommittee of the Senate Committee on Armed Services, headed by Senator Stuart W. Symington, set out to find an answer in the course of hearings which started on April 16th, 1956, and continued for several weeks.

The report published by the Symington subcommittee at the end of January 1957 runs to 128 pages. It is based on the study of thousands of documents and the sworn testimony of 100 prominent witnesses from the most varied branches of the U.S. civil and military administration—generals, admirals, ministers and scientists. The published reports on the hearings cover 1,863 pages of print.

*

At 56, Stuart W. Symington can not only be described as one of the younger Senators. He is also fully capable of holding his own in the Senate. Tall and handsome, he has proved himself to be a formidable fighter when the occasion demands it. And whenever the question of airpower arises, he is ready to take up the cudgels.

Democratic Senator Symington was appointed the first Secretary of the Air Force in 1947, when the U.S.A.F. became an independent service, and remained in this post until 1950. His period of office thus covered a whole series of events which inevitably sharpened the hearing of an Air Force Secretary: the beginning of the Cold War, the publication of the Finletter Report entitled "Survival in the Air Age", the Berlin blockade, the Navy-Air Force battle over strategic air warfare. The outbreak of the Korean War found Symington in the post of Chairman of the National Security Resources Board.

A staunch Democrat, he withdrew from all public offices when the Republicans came to power. However, he by no means went into the "wilderness", but into the Opposition, jealously watching over the Air Force's aircraft and personnel strength. When anyone mentioned cuts in the Air Force budget in his presence, he saw red. And as there has been repeated talk of such cuts in recent years, Symington's tone became more militant from month to month. He pressed for a thorough official investigation of the relative strength of the United States and Russia, and as he was a member of the influential Senate Committee on Armed Services his demands could not be ignored indefinitely.

In February 1956 the Armed Services Committee appointed a Subcommittee on the Air Force, with Symington as Chairman. Other members were Democrats H. M. Jackson and S. J. Ervin, and Republicans L. Saltonstall and former Senator J. H. Duff.

To cut a long story short, the five Senators did not reach unanimity in their findings, so that the report contains not only the conclusions reached by the three Democratic members but also the minority views held by Republican Senator Saltonstall. But whether unanimous or not, the Symington report merits a brief summary, in view of the tremendous sums which the United States annually spends on its air arms.

Parade of the witnesses

The Subcommittee's hearings covered the following seven points:

"1. The adequacy of present plans and programs to maintain an air force capable of defeating enemy air forces in strategic air warfare and controlling vital air areas.

2. The adequacy of present plans and programs to maintain an air force capable of defending the United States against air attack.

3. The adequacy of present plans and programs to maintain an air force capable of gaining and maintaining general air superiority.

4. The adequacy of naval airpower to carry out its assigned missions.

5. Airpower and the modern army.

6. The present policies that determine the relation between fiscal considerations and national defense considerations.

7. The present and prospective position of the United States and of the Soviet Union as to the principal elements of airpower."

Senator Stuart W. Symington.

Even the most concentrated summary of the testimonies heard would be far beyond the scope of the present article. Secretary of Defense Charles E. Wilson, Secretary of the Air Force Donald A. Quarles, Air Force Chief of Staff General Nathan F. Twining, the then Secretary of the Navy Charles S. Thomas, Chief of Naval Operations Admiral Arleigh Burke, Army Chief of Staff General Maxwell D. Taylor, even Dr. Wernher von Braun, Director of the Development Operations Division, Army Ballistic Missile Agency, Redstone Arsenal, and many others took the stand. In brief, virtually everybody of standing at the Pentagon, in the services or the research centres testified on oath before the Symington committee. When Air Force Generals Twining, Putt and Irvine returned to Washington from their visit to Moscow in the Summer of 1956, they were called a second time and cross-examined for three days.

*

On the basis of these testimonies the Senators came to the following conclusions regarding the relative preparedness of the United States and the Soviet Union:

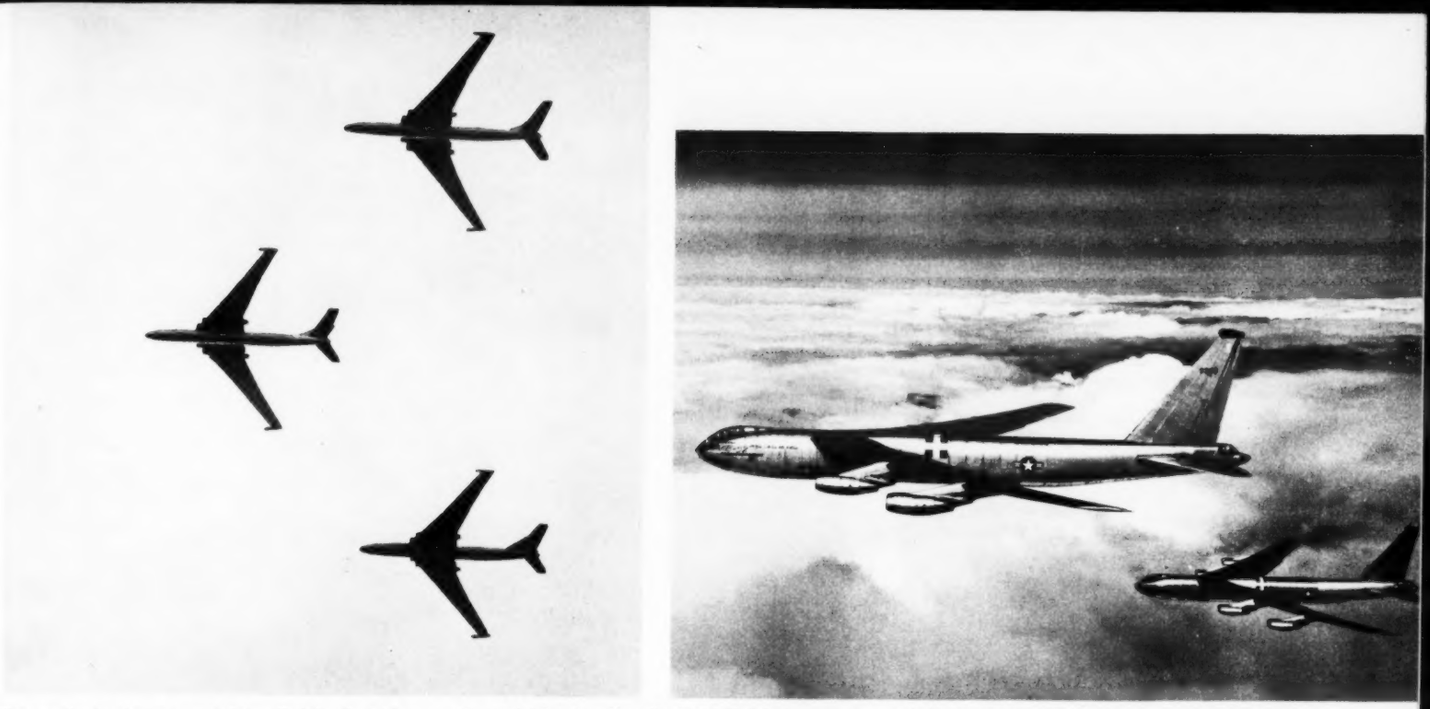
- **"Aircraft production.**—At the present time the Soviet is producing more combat aircraft than the United States, and in the past 3 years the Soviet has outproduced the United States in modern combat aircraft . . .
- **Aircraft in operational units.**—At the present time Russia has thousands more aircraft in combat units than the United States . . .
- **Fighter planes.**—The Soviet is currently producing about 10 times more fighter planes than the United States and has more jet fighters in operational units than all types of jet aircraft combined in United States operational units . . .
- **Light bombers.**—The Soviet has many more light jet bombers in operation than the United States . . .
- **Medium bombers.**—The United States has several times as many medium jet bombers as the Soviet . . .
- **Heavy bombers.**—The Soviet now has more jet heavy bombers than the United States and is producing these bombers at a faster rate . . .
- **Research and development**

1. General: The Soviets are progressing in this field at a faster rate than the United States in the development and production of new type scientific weapons and, if present plans and programs of the United States are not changed, the U.S.S.R. will attain superiority in this field . . .

2. Scientific and engineering personnel: Russia is currently graduating twice as many trained scientists and engineers per year as the United States . . .

3. The Soviet has high energy physics research facilities superior to any others in the world, and Soviet researchers are very capable . . .

4. Missiles: Russia started earlier in the development of ballistic missiles than did the United States and is believed to have made substantial progress in this field, to the extent of having exceeded the United States at least in some aspects of the ICBM and IRBM . . .



Whereas the Symington report claims that the Soviet has more heavy jet bombers than the U.S.A.F., latest reports seem to indicate that the U.S.A. is still in the lead, with about 150 Boeing B-52's delivered (February 1957), as against about 100 Ilyushin *Bisons*.

5. The Soviet has in operational aircraft jet engines with substantially more thrust than any the United States has in operation . . ."

As a small sample of the testimonies on which the Senators' conclusions were based, the question of strategic bombers may be cited. As a result of statements by Generals Nathan F. Twining, Air Force Chief of Staff, and Curtis E. LeMay, Commander-in-Chief, Strategic Air Command, the Senators reached the conviction that there are more long-range jet bombers of the B-52 class in operation in the Soviet Union than in the United States. General Twining stated that he had requested six additional wings of long-range jet bombers, or in other words about 300 extra B-52s, but that his request had been held up for months in the Joint Chiefs of Staff. If present plans and programs were not changed, the Russian long-range air force would be stronger than that of the United States by 1958—60.

Majority and minority

Up to this point in the proceedings the three Democrats and the two Republicans were all more or less in agreement. But when it came to drawing up the balance sheet, their ways parted.

The major conclusions reached by the Democratic Senators can be summarized as follows:

- The United States defenses have been weakened because the authorities have failed to act on intelligence information and have tended to ignore or under-estimate Soviet arms progress.
- The Soviet Union already has more modern combat aircraft in service than the United States and is also producing more. Compared with the United States, they have cut the time elapsing between original design and quantity production.
- The Soviet lag in quality is rapidly being made good. Yet the Americans are still insisting on their qualitative lead in order to justify their having lost the quantitative lead.
- Though the United States has the production capacity to maintain an air power superior to the Russians', the Department of Defense has not utilized this capacity. Financial considerations have frequently been placed ahead of defense requirements, to the detriment of national security.
- The Department of Defense has permitted the three services to compete among themselves in the development and production of missiles.
- The Department of Defense delayed in giving overriding priority to the ballistic missile programme. The result has been a serious loss of time compared with rapid Russian advances in this field.
- The efficiency of the United States' strategic striking power and of the air defense system depends to a great extent on an adequate air base structure both at home and abroad. But this structure is at present insufficient, so that it affords neither the alert status nor the dispersal required for security. The deficiency in the continental United States is becoming increasingly dangerous as the range of the Soviet offensive force grows, and the overseas base structure deteriorates.
- The decline in the U.S.A.F.'s strategic striking power cannot be made good by the use of naval air power. Moreover, present planning of naval strength does not provide adequate protection against enemy submarine attacks on shipping or submarine missile attacks on the mainland.

"He said he will not do the mission unless he gets *two* bananas..."

- The United States form of government gives the American people not only the right, but also the need, to be supplied with all the information on defense compatible with security considerations. Nevertheless, the public is not properly informed about United States strength or about the growing military strength of Soviet Russia. "The public has failed to receive from official sources complete, accurate and timely information which it has the right to know."

Republican Senator Saltonstall's conclusions differ from the majority views on the following points:

- The majority report takes an unduly pessimistic view of the present state and future planning of U. S. air power.
- The report is not sufficiently objective, since it does not take all relevant testimony into account.
- The United States' combined air, naval and ground strength is superior to the Soviet Union's today.
- Saltonstall is confident that all who are responsible for U. S. defense will continue to provide adequate military strength, of which air power is the vital segment.
- The United States can never compete with the Soviet Union in numbers, nor does it wish to. What America needs are balanced land, sea and air forces capable of deterring an aggressor or retaliating immediately in the event of attack. These forces can never reach the stage of absolute perfection, as there will always be improvements through new weapons and equipment. "Vast programs to this end are now in progress. We can be optimistic about them and take confidence from the many instances of solid accomplishment."

Without taking sides in the arguments and counter-arguments put forward by the U.S. Senators, reference can nevertheless be made to the gradual transfer now being made from piloted aircraft to guided missiles, as a result of which much of the present dispute may well lose its significance. Finally, it should also not be overlooked that responsible American spokesmen, such as Defense Secretary Charles E. Wilson and General Nathan F. Twining, have only recently made more optimistic statements on U.S. defense. In their view, there is no question of a decline in American air power or of its being outpaced by Soviet Russia.

The C-132 Super Transport

The Tulsa, Oklahoma, division of Douglas Aircraft Company has for some time been engaged on the development of a giant transport aircraft for the U.S. Air Force. A full-size mockup of the machine was shown to the public for the first time in February this year. As the pictures on this page seem to indicate, the load capacity of this colossus, with its span of 178 ft. and length of 187 ft., put all earlier superlatives in the shade. The main cargo compartment is nearly 95 ft. long, more than 17 ft. wide and 12½ ft. high; the forward cargo door is 9 ft. square.

The manufacturers announce that the C-132 will carry a payload of 100,000 lbs. over 3,500 nautical miles, at a cruising speed of more than 400 knots. Maximum payload over short stages is reported to be no less than 200,000 lbs., and maximum gross weight (with overload) roughly 500,000 lbs. Nevertheless it is claimed that the C-132 will be able to operate from normal runways at today's bigger military and civil airfields.

The slightly swept shoulder-wing monoplane with double-deck fuselage and upswept tail (the latter with large loading door and ramp) rests on a main undercarriage with at least eight wheels, retracted during flight into bulges on the fuselage, and a nose wheel unit. Power will be supplied by four Pratt & Whitney T57 super-powerful propeller turbines (still under development) of 15,000 s.h.p. each (plus residual thrust), driving four single propellers 20 ft. in diameter, each with four deep-chord blades.

As these lines go to print, however, it is learned that the U.S.A.F. contract for the C-132 has been cancelled, as the transports already in production are considered adequate for foreseeable needs.

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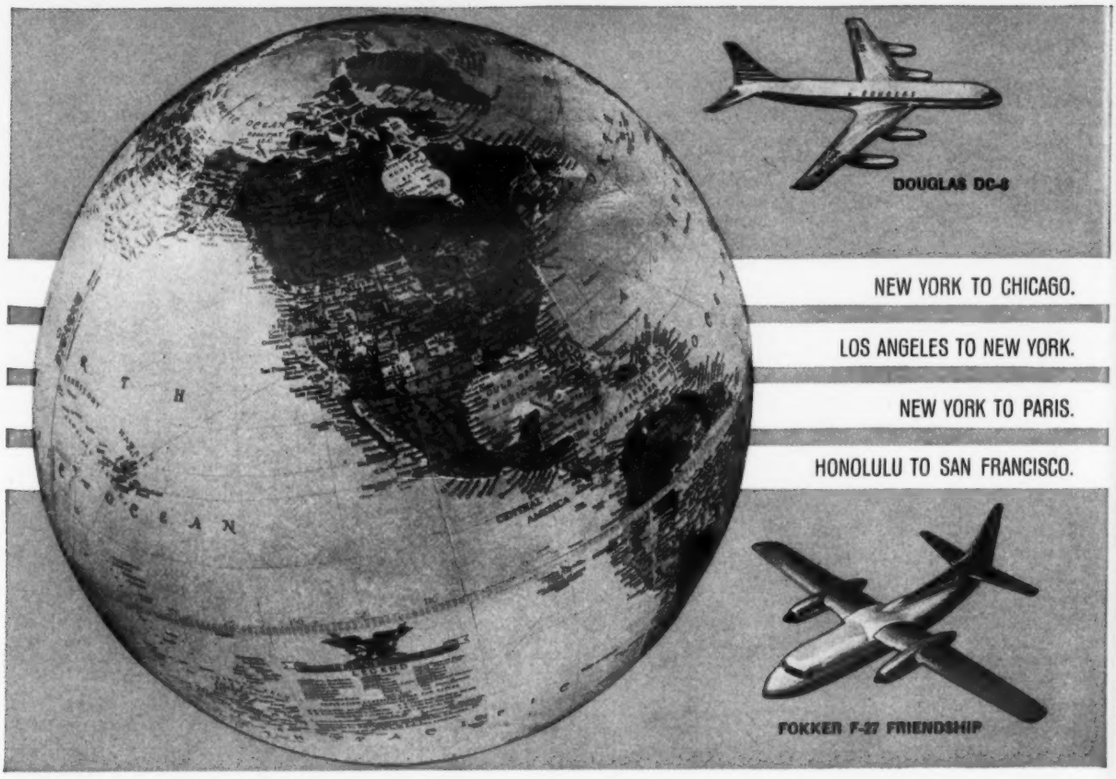

Jet airliners shrink globe . . .

When you and your family board these new jet airliners, you'll be stepping into a completely new era of transportation designed to get you where you are going faster, more comfortably and more dependably. To appreciate the progress that has been made, following are some exclusive jet problems that had to be licked and some original answers to those problems worked out by Bendix Aviation Corporation.

For example, the starting, generating and ignition systems used on reciprocating engines were not applicable on jets. One of our new Bendix jet starters, small enough to put in a breadbox, produces 450 h.p. to crank a giant jet engine 1800 r.p.m. in three and a half seconds.

Igniting a jet is like lighting a match in a tornado. An ordinary spark has no chance. New Bendix jet ignition produces a super spark that fires jet engines immediately.

Jets are fuel hogs with very sensitive digestive systems. Not too much, not too little—the mixture's got to be just right. Speed, temperature and altitude affect this mixture. Thus, fuel-air proportions must be changed rapidly and automatically. New Bendix* fuel-metering and engine control systems are precise and automatic, take another tough problem off the crew's backs.

Jet speeds necessitate more accurate navigation and piloting. Here several exclusive Bendix devices team up for greater precision: The

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RADIO COMMUNICATION SYSTEM
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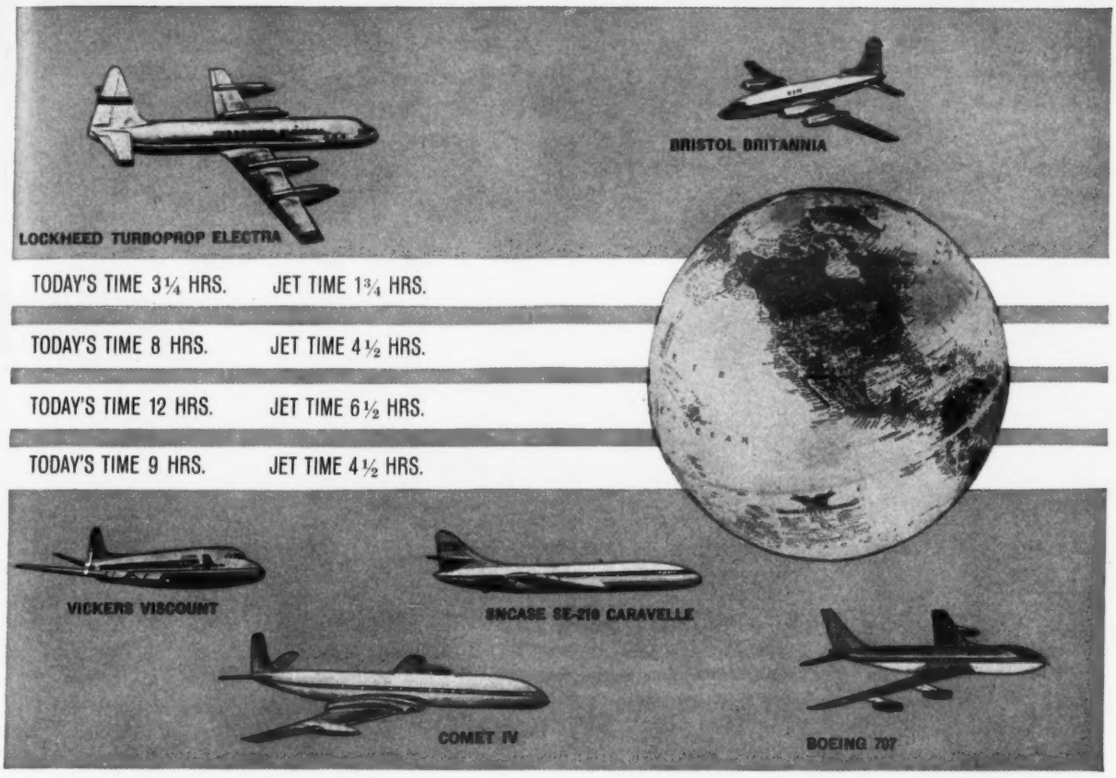
Automatic high-altitude oxygen system for passengers plus flight crew oxygen system.

SPECIAL INSTRUMENTS
To measure Mach airspeed and fuel flow; accelerometers; specially lighted turn-and-bank and rate-of-climb indicators.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TODAY'S TIME 8 HRS. JET TIME 4½ HRS.
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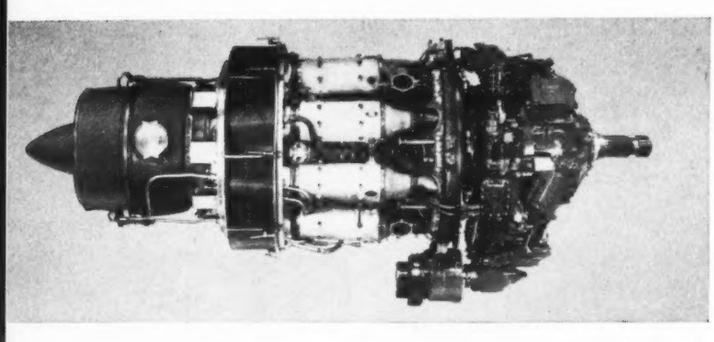
Efficient over a wide range of operating conditions, the Proteus has the lowest specific fuel consumption of any gas turbine in service . . . military or civil.

The remarkable quietness of the Proteus derives from the free-turbine principle, which permits flexibility in the choice of propeller speed.

80,000 hours' ground and flight running lie behind the Proteus. It started airline operation with an unconditional overhaul life of 500 hours; this has already risen to 650 hours and is soon expected to rise to 850 hours. The Proteus has already successfully completed a 1,000-hour endurance test.



BRISTOL
Proteus

BRISTOL AERO-ENGINES LIMITED

Top Priority for the I.C.B.M.

By Interavia's Washington Correspondent

A new concept in contractor relations which may set the pattern for future development of big missiles is being tested by the Air Force in the ballistic missiles programme. In effect, Western Development Division of the Air Research and Development Command, headed by 46-year old Major General Bernard A. Schriever, is the prime weapon system contractor responsible for the development, production and initial training of personnel for the intercontinental ballistic missile and the intermediate range missile.

Sitting on one side of WDD is a civilian contractor—Ramo-Wooldridge Corp., of Inglewood, California—whereas on the other is a military agency—the Ballistic Missile Office of the Air Materiel Command, of which Brig. Gen. Ben I. Funk is the chief.

Ramo-Wooldridge, under the three-pronged management organization, serves as technical assistant to WDD under the terms of a contract giving the company its cost-plus-fees in excess of six per cent (the normal margin allowed on contracts) in consideration for an agreement not to manufacture hardware for the missiles system.

The job of the Ballistic Missile Office and of Ramo-Wooldridge is to supervise and coordinate the multitude of contracts which have been awarded in the drive for the development of America's intercontinental ballistic missile in a minimum of time.

The new concept was superimposed on the original ballistic missile contractor, Convair Division of General Dynamics Corporation, following a Defense Department analysis of the programme which indicated that a variety of measures were required to speed development of the 5,000 mile range missile.

The new combination started work about two years ago, shortly after Congress criticized the slow progress of the ballistic mis-

I.C.B.M. Top Brass: Left to right: *Major General B. A. Schriever*, Commander of the Western Development Division; *Brigadier General Ben Iran Funk*, Deputy Director for Ballistic Missiles, Directorate of Procurement and Production, Headquarters, U.S.A.F. Air Materiel Command, with offices in Los Angeles, Calif.; he is in charge of the Ballistic Missile Office; *Dr. Simon Ramo*, Executive Vice President, Secretary and a Director of the Ramo-Wooldridge Corporation, Los Angeles, the civilian contractor to the I.C.B.M. programme. Ramo formerly was Director of Guided Missile Research and Development and later Vice President and Director of Operations for Hughes Aircraft Co.

General Schriever

That Major General Schriever does not concentrate his imagination on such practical problems as the development of the Inter-Continental Ballistic Missile alone became obvious at the Astronautics Symposium which was organized at San Diego, Calif., by the U. S. Air Force's Office of Scientific Research and Convair Division of General Dynamics Corporation. The quality of the five hundred top scientists and executives who attended the event brusquely elevated the subject of astronautics—which hitherto had been indulgently tolerated by most and ridiculed by others—to the level of scientific respectability.

Schriever startled his audience by stating that it would not be too difficult to extend the present developments in the field of the ICBM to surface-to-surface transport or space travel of personnel at some time in the future. Indeed, in the long haul the safety of the American nation might depend upon its achieving "space superiority", the General said. Several decades from now the important battles might not be sea battles or air battles, but *space battles*, and the U. S. should be spending a certain fraction of its national resources to ensure that it did not lag in obtaining space supremacy. Besides the direct military importance of space, America's prestige as world leader might well dictate that it undertake lunar expeditions and even interplanetary flight when the appropriate technological advances had been made and the time was ripe . . .

Bernard Adolph Schriever was born in Bremen, Germany, on September 14th, 1910, came to the United States in 1917 and was naturalized a U. S. citizen in 1923. He received most of his schooling in Texas and graduated in 1931 with a Bachelor of Science degree, which he completed with a Master of Science degree from Stamford University, Palo Alto, in 1942.

He joined the Army in 1931 and began flying training in 1932. Five years later he became a pilot with Northwest Airlines but returned to the Army in 1938; in 1939 he was appointed a test pilot at Wright Field and attended the Air Corps Engineering School.

Schriever performed his World War II active service as a bomber pilot in the Pacific and flew sixty-three combat missions. After the war he served as Chief of the Scientific Liaison Section at Air Force Headquarters. In May 1954 he became Assistant to the Commander of Air Research and Development Command, and in August of the same year he was also appointed Commander of the Western Development Division with headquarters at Los Angeles.—In 1938 he married Dora Brett, daughter of Lieutenant General George H. Brett, one of the best-known veterans of the Army Air Corps and the war-time Army Air Forces.

Predecessor to the Convair *Atlas* I.C.B.M. was the MX-774, one of America's first supersonic self-launched rockets.

Western Development Division's first Re-entry Test Vehicle is the Lockheed X-17 three-stage rocket, several of which have been fired from Patrick Air Force Base, Florida.

sile programme. In the two year period some 16 major contracts have been awarded under a principle calling for "selective" competition and alternate designs of major sub-systems.

Two contractors are working on separate development of the "bird" itself—Convair Division of General Dynamics, San Diego, Calif., on *Atlas* and the Glenn L. Martin Co., Baltimore, Maryland, on *Titan*. The *Titan* programme is reportedly at least a year behind *Atlas* in each stage of its development cycle.

The big "bird" is expected to have a range of at least 5,000 miles, a speed above 8,100 miles an hour (13,100 km/h) and to travel more than 500 miles above the earth's surface. Design accuracy aims at placing the missile within five miles of a specified target.

The difficulty of the assignment can perhaps best be determined by figures made available by Air Force Secretary Donald A. Quarles when he told newsmen some time ago that the German V-2 missile had a margin of error of two per cent of the range. Quarles translated that as follows: "The V-2 missile was up to about 200-mile range, so that they would expect, if they had achieved an accuracy of 2 per cent of the range, to put half the missiles within a circle of four mile radius."

"Now that doesn't sound at all good for a tactical weapon of 200-mile range and you can imagine that this wouldn't be a very attractive characteristic. But when you get up to a 1,000-mile range, 2 per cent of it is 20-mile radius and that gets to look quite impossible, and if you go up to a 5,000 mile range, you have a circle of a 100-mile radius. So I think you see that we have to improve that situation by something like a factor of 10 to have something that looks good."

To put half the missiles in a circle with a four-mile radius, at a range of 5,000 miles, Quarles concluded, a margin of probable error could probably be no greater than two-tenths of one percent (0.002).

In addition to the two big "birds", WDD is responsible for the development of the 1,500-mile range Douglas *Thor* intermediate ballistic missile, the first of which was tested at Patrick Air Force Base, Florida, in January with unconvincing results (it rose to a short height, crashed back on to the ground and burned up).

The size of the programme was illustrated by the announcement early this year that three contracts totalling more than $ 570,000,000 had been awarded for airframes for the missiles. These contracts included $ 145,000,000 to Convair Division, $ 358,000,000 to Martin and $ 67,000,000 to Douglas.

Major sub-systems, all interchangeable, for which prime contracts have been let include: nose cone, one contract each to General Electric Co. for *Atlas* and to AVCO of Stratford, Conn., for *Titan*. Lockheed Aircraft at Burbank, Calif. has what has been described as a supporting nose cone research contract. Actually, it is understood that Lockheed has built a special test vehicle (X-17) which has been flight tested during the last six months.

Part of the GE and AVCO jobs is to conduct extensive studies on the effect of heat. Materials testing is a continuing project. This means, according to Brig. Gen. Don R. Ostrander, Assistant for Guided Missile Systems at Headquarters of Air Research and Development Command, Baltimore, Maryland, that "samples of various metals and metal structures are subjected to intense heating to determine their capabilities. Special rocket test vehicles are used to validate research data on heating and other problem areas encountered as a vehicle re-enters the earth's atmosphere... The problem of re-entry has been one of our greatest concerns from a technical standpoint. However, actual flight tests of a special test vehicle during the past six months have

Who does what for the I.C.B.M.

Airframe Contractors:
- Convair (Atlas)
- Glenn L. Martin (Titan)
- Douglas Aircraft (Thor I.R.B.M.)

Propulsion Contractors:
- Aerojet General Corp.
- North American Aviation
- American Machine and Foundry Corp.

Nose Cone Contractors:
- Avco Manufacturing Co.
- General Electric Co.
- Lockheed Aircraft

Guidance Contractors:
- A. C. Spark Plug Div., G. M.
- Arma Corp.
- Burroughs Corp.
- General Electric Co.
- Massachusetts Institute of Technology
- Remington Rand Corp.
- Western Electric Co.

Government Agencies:
- Air Force Dept.
- Army Dept.
- Navy Dept.
- State Dept.
- Dept. of Interior
- National Advisory Committee for Aeronautics
- Atomic Energy Commission

increased our confidence that we will solve the problem."

Propulsion contractors include North American Aviation's Rocketdyne Division at Canoga Park, Calif., where liquid-propellant rockets are being tested in the Santa Susana Mountains, near Los Angeles, and the propulsion facilities of Aerojet General Corp. of Azusa and Sacramento, Calif. At present the Air Force is erecting a $ 13,000,000 production facility for North American at Neosho, Missouri. A plant costing the same amount is being built for Aerojet General Corp. Booster rockets are being developed by American Machine & Foundry Company, Pomona, Calif.

The guidance system for the missiles is being developed by: General Electric Co., Syracuse, N.Y.; Bell Telephone Laboratories, Whippany, N.J.; American Bosch Arma, Garden City, Long Island, N.Y.; and the A.C. Spark Plug Division of General Motors, Milwaukee, Wisconsin. Burroughs Corporation, of Paoli, Pennsylvania, and Remington Rand's Univac Division are working on the computer and data processing machines so important to placing the missiles on course.

Backing up the work of the principal contractors are over 200 sub-contractors, including many research laboratories which are working on the ability of electronic components to withstand stresses and the varied environmental conditions the missiles will face during the 5,000 mile flight. In all, some 70,000 individuals are associated with the programme on an overtime basis. In addition, the programme has top priority on materials and components which may be in short supply.

Overall policy on the ballistic missile programme is controlled by two special committees. One is the Secretary of Defense's Committee headed by Special Assistant Eger V. Murphree, commonly referred to in Pentagon circles as the "Missile Czar." The other is an Air Force Committee headed by Air Force Secretary Donald A. Quarles.

In its eagerness to get production of the long range ballistic missile under way, the Air Force politely side-stepped a volley of congressional criticism stemming from the sensitive dispersal programme and authorized Convair's Astronautics Division to start building a $ 30,000,000 plant near San Diego, Calif. Convair will foot the bill of about one-half of the cost.

This facility will cover more than 1,000,000 square feet and should be finished before the end of this year. Employment will top the 6,600 mark. In the meantime, construction is moving ahead at Patrick Air Force Base, where the Air Force hopes to fire an Atlas missile before the end of next year, and at Edwards Air Force Base, testing ground for the motors. Construction is also scheduled for Camp Cooke, Calif., where personnel will be trained to handle the missiles.

The imminence of the test programme is underlined by the recent recruiting by Ramo-Wooldridge of a technical staff to work on the test programme at Patrick Air Force Base. Douglas and Convair are also reported to be recruiting for Patrick.

World Air Power No. 4

A Review of Swedish Aeronautics

Military

Like most of the world's major air arms, the Royal Swedish Air Force entered 1957 with some uncertainty about the future. The reasons for this are the much-criticized cuts made by the Government in the Air Force budget requests for fiscal 1957—58 and in the estimates for the 1957—64 long-term aircraft procurement programme. Allocations under the latter programme (under which new orders are authorized every year), were originally scheduled to be increased from the present estimate of Swedish Kr. 3,656,000,000 to over Swedish Kr. 5,000,000,000, but were actually left unchanged. Instead of a planned increase in the combat aircraft strength by 22 percent, this unchanged procurement programme will ultimately result in a 20 percent drop in the current strength, unless remedial action is taken in 1958. The expansion plans would have called for the strengthening and modernization of Sweden's night fighter defence which now consists of one wing only (three squadrons). As a result of the procurement cuts, no funds are now available for the projected increase in the production of the Saab J 32B *Lansen* two-seater transonic night fighter.

Pilot and radar observer... the combat team of a Swedish night fighter.

A de Havilland *Venom NF. Mk. 2* (Swedish designation J 33) on night operations.

Supersonic all-weather fighters of the Saab J 35 *Draken* type will shortly be delivered to the squadrons.

In the *day-fighter defence* (10 wings with a total of 30 squadrons) most units fly the Saab J 29; increasing numbers of the modernized J 29F version (afterburner, doubled climb rate, higher service ceiling and critical Mach number) are going into service. The Hawker *Hunter* F. Mk. 4's (J 34), which were acquired as an intermediate measure of modernization pending the arrival of the Saab J 35 *Draken* supersonic fighter, are now well established in service, and during 1956 three squadrons were re-equipped with this type. Three more squadrons will receive J 34's in 1957. Meanwhile, the J 35 *Draken* has gone into quantity production.

During 1956 a most important modernization of the Swedish Air Force's *Attack Force* (or Tactical Air Force) was begun with the introduction into service of the Saab A 32A *Lansen* transonic all-weather attack aircraft. The A 32A—which has no counterpart in service in Western Europe—will eventually re-equip all Swedish attack units. During 1956, no fewer than six squadrons were equipped with this type, with six more to follow in 1957.

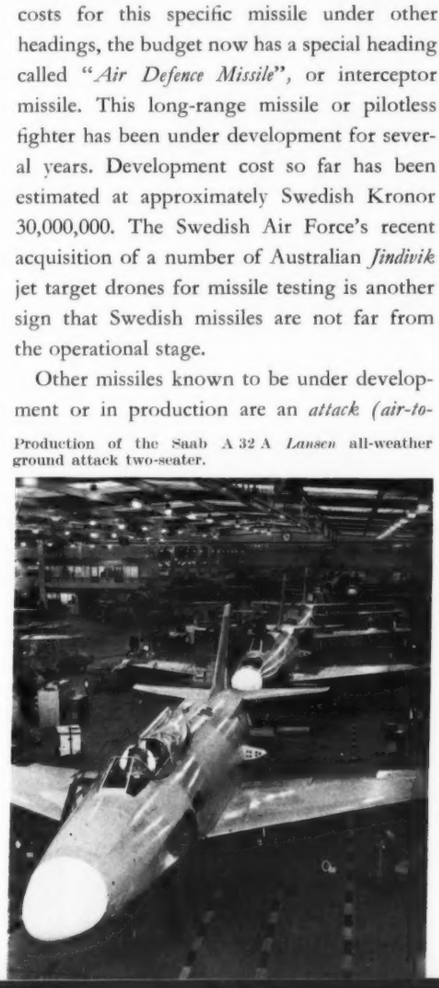
The Air Force's *reconnaissance force* is now fully equipped with Saab S 29C photographic reconnaissance aircraft, but a number of piston-engined Saab S 18As are still flying around for all-weather reconnaissance. These will be replaced by a reconnaissance version of the *Lansen*.

The year 1956 was the first full year in which the Air Force employed its new pilot training scheme of using the 190 h.p. Saab-91B *Safir* (Sk 50) as the sole trainer before changing over direct to the jet-propelled de Havilland *Vampire Trainer* (J 28C). The system has worked well and saves both valuable training time and money. Because more *Vampire Trainers* are needed, the Swedish Air Force some time ago obtained permission to order *Vampire Trainer* fuselages and equipment in Britain for the purpose of converting 20 single-seat *Vampires* into dual-control trainers. Previously the Swedish Air Force had bought some 45 *Vampire Trainers* direct from England.

Although *guided missiles* have been under development in Sweden for many years (Saab recently disclosed that it accomplished the first successful Swedish missile firing 10 years ago), very little information has been released by the Air Force's Guided Weapons Bureau, the organization responsible for all Swedish missile development and production. Certain missile information has, however, been released in connection with new aircraft types, and funds for missile procurement—both airborne and surface-to-air types—have figured in the defence budgets for several years. Owing to the fact that the Guided Weapons Bureau has entered upon a project of such a scale that it was no longer practical to conceal the development costs for this specific missile under other headings, the budget now has a special heading called "*Air Defence Missile*", or interceptor missile. This long-range missile or pilotless fighter has been under development for several years. Development cost so far has been estimated at approximately Swedish Kronor 30,000,000. The Swedish Air Force's recent acquisition of a number of Australian *Jindivik* jet target drones for missile testing is another sign that Swedish missiles are not far from the operational stage.

Other missiles known to be under development or in production are an *attack (air-to-surface) missile*, which, it was stated long ago, was expected to be ready at the same time as the A 32A *Lansen* (which was late in 1955). Air Force spokesmen have also repeatedly stated that all Swedish fighters will be equipped with *air-to-air missiles*, and such missiles will also form the main armament of the Saab J 35 supersonic fighter. In addition, the Swedish Navy has repeatedly referred to a *coastal defence missile* intended to replace the Navy's heavy coastal artillery batteries.

Production of the Saab A 32 A *Lansen* all-weather ground attack two-seater.



Aircraft Industrial

Sweden's aeronautical industry continues to grow and today employs nearly 10,000 people, mainly at Saab and Svenska Flygmotor. In addition, there are numerous sub-contractors.

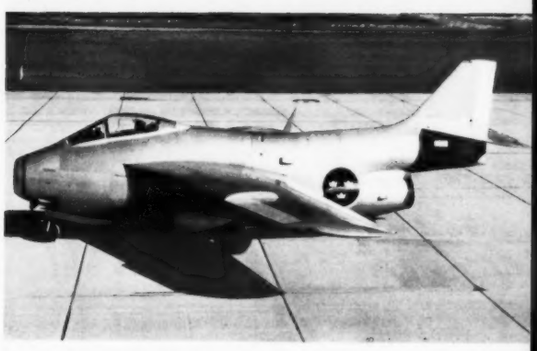
At *Saab*, quantity production of the A 32A *Lansen* all-weather attack aircraft is running according to schedule. In January of this year, the more powerful J 32B *Lansen* all-weather and night fighter version made its initial flight and is to follow the A 32A into production. Whether it will be produced to re-equip more squadrons than those now flying the D.H. *Venom* N.F. Mk. 51 (J 33) night fighters is still uncertain, however, due to the recent budget cuts. A reconnaissance version of the *Lansen* is also due. Some *Lansens* are being flown with dual controls for training purposes.

Saab has now also started quantity production of the new supersonic J 35 *Draken* all-weather supersonic fighter. The J 35 is particularly remarkable for its excellent low-speed characteristics and short take-off run. In the Swedish Air Force the J 35 will eventually replace the J 29 and consequently give all-weather operations capability to the current day-fighter defence force. A dual-control trainer version of the J 35 will also be built.

Although production of new J 29s was completed in April 1956, a large number of "Twenty-Nines" are still rolling through the Saab factories for modernization (J 29F standard). In addition, Saab is currently manufacturing a new series of *Safir* trainer-tourers to cope with recent export orders. The Royal Norwegian Air Force is at present taking delivery of 25 aircraft of the 91B-2 three-seat version, but the four-seat 91C model has also been the subject of recent orders. More *Safir* export orders are foreseen.

The Company's engineering and production facilities are quickly expanding. During 1956, the Company's *Trollhättan* factory (mainly producing motor cars, aircraft wings and other

The sonic-speed Saab J 32 B *Lansen* will shortly go into service with the Swedish Air Force's night fighter squadrons.



Saab J 29 F day fighter (with afterburner).

aircraft components, as well as jet engine parts), inaugurated a new extension. For this and other expansion projects at Trollhättan a total of Swedish Kronor 9,000,000 is currently being invested. A further large extension of the Trollhättan factory awaits approval from the authorities. At *Jönköping,* south of lake Vaettern, Saab recently started to move into a completely new factory to be used for the Company's expanding development and production of equipment for aircraft and missiles. More than 500 people are now employed at Jönköping. Saab has a 7-year lease to a factory at *Stensholm* near Jönköping, also mainly for equipment production. At *Södertälje,* south of Stockholm, the Company in 1956 acquired a factory specializing in hydraulic equipment and precision tools. In *Stockholm, Saab* in 1956 opened an engineering office mainly for systems analysis work. Furthermore, *Saab* recently decided to move its production of electronic equipment to a new facility near its *Gothen factory* (mainly producing car engines and gear boxes).

Finally, at the main factory in *Linköping* considerable expansion is again under way, including extension of one of the aircraft assembly buildings, the tool shops (for tool manufacture another factory was recently purchased in Linköping) and engineering facilities. A new two-storey building is being built for fuel and rig testing of complete fuel systems, apparatus, pressure chambers, etc. Further large-scale expansion is planned at Linköping. (Though outside the scope of this survey, it may be mentioned that since 1950 *Saab* has been able to establish itself as a major producer of motor cars in spite of heavy competition from Swedish and foreign concerns. During 1957, *Saab's* motor car production will increase by 40 percent to 10,000 vehicles per year. Some 200 *Saab* cars are currently being exported monthly to the United States.)

Svenska Flygmotor's activities are also undergoing considerable expansion mainly in connection with the coming licence-production of a new version of the Rolls-Royce *Avon* (RM 6 in Sweden) for the Saab J 35 and the development of several completely new types of engine for the Air Force. Although no details have been released, it is common knowledge that Flygmotor is deeply engaged in ramjet engine development (probably for missiles — Ed.). Flygmotor's current major production item is, however, the Rolls-Royce *Avon* RA.7R (RM 5 in Sweden) for the Saab A 32 A. Excellent progress has been made in Sweden on afterburners, and several successful designs have been developed by the Royal Swedish Air Board and Flygmotor in collaboration. The first to be developed was for the licence-built D.H. *Ghost 50* (RM 2 in Sweden), the afterburning version of which is designated the RM 2B. It delivers a static thrust, with afterburner, of 2,800 kp (6,200 lbs.). The second Swedish-developed afterburner is for the new Rolls-Royce *Avon* (RM 6) powering the J 32B.

Svenska Flygmotor AB today employs more than 2,000 people, and its annual sales value totals some Swedish Kronor 85,000,000. (Saab's annual sales are a secret—Ed.). It is interesting to note that the sheet metal parts used in Flygmotor's jet engine production are manufactured by Saab in their large motorcar body presses.

Saab 91 B *Safir* (Sk. 50) basic trainer.

Civil Aviation

Swedish civil aviation could nowadays almost as well be called Scandinavian because of SAS. The Company's major accomplishment this year no doubt is the inauguration on February 24th of the first commercial air service over the geographical North Pole on the Scandinavia—Japan route. This Polar "short cut" will reduce travel time from 52 hours to 30 hours and cut the distance by 3,700 km (2,300 miles) as compared with the "conventional route" via the Middle East and India. A further cut in travel time to 17 hours will be made possible when the DC-8 jet airliners come into operation in 1960.

January 1960 is a magic date in Swedish civil aviation. By then a new international airport must be ready for use at Stockholm, as Bromma airport cannot accommodate the DC-8s. The new airport is now to be built at Skå-Edeby, a site only 16 km (10 miles) from the Stockholm city centre. Skå-Edeby was considered once before but was ruled out because of the unfavourable soil conditions. Thanks to new geological advances, however, an airport there is now perfectly feasible. Total cost of the airport has been estimated at Swedish Kronor 180,000,000 ($ 36,000,000). An initial Swedish Kronor 25,000,000 has been reserved in the 1957—58 budget. In addition to this project, the Board of Civil Aviation will strengthen the runway at Gothenburg-Torslanda airport to accommodate the DC-7C, erect a new station building at Malmoe-Bulltofta for nearly Swedish Kronor 4,000,000. VOR beacons have been authorized for the Gothenburg—Stockholm—Finland airway for Swedish Kronor 900,000, and radar links in the Stockholm area for Swedish Kronor 300,000. A surveillance radar installation for the Gothenburg area has also been approved.

What's in the Air?

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AIR TRANSPORTATION

● **Mexico and the United States** have concluded a commercial air agreement putting an end to a dispute of many years' standing. Under the accord, which runs until June 30th, 1959, Mexican airlines are authorized to inaugurate services on the following routes: Mexico City–Washington–New York, Mexico City–Chicago, Mexico City–New Orleans and Mexico City–San Antonio, Texas. Authorization is also given to Mexican carriers to continue services already being operated on the Mexico City–Los Angeles and Mexico City–Miami routes.– United States companies have the right to fly on the following routes: New York–Washington–Mexico City, Chicago-Dallas–San Antonio–Mexico City, Los Angeles–Mexico City, New Orleans–Mexico City, New Orleans–Merida, Miami–Merida, Houston–Brownsville–Tampico–Mexico City–Tapachula–Guatemala.

● **Six U.S. airlines** have asked the Civil Aeronautics Board to approve a 6% increase in passenger fares beginning April 1st. The airlines are Braniff, Capital, Eastern, Northwest, T.W.A. and United Airlines. The companies told the Board that costs had increased in every sphere, including wages, fuel and other materials and supplies. There had been no general fare increase since 1952.

● **Air-India International** has negotiated a loan totalling $ 11,200,000 from five U.S. commercial banks, First National City Bank of New York, Bank of America N.T. & S.A., Chase Manhattan Bank, Irving Trust Co. and First National Bank of Boston, as well as of $ 5,600,000 from the World Bank. These funds will be used to finance the dollar costs of purchasing three Boeing jet transports (707-420 version) each fitted with four Rolls-Royce *Conways*, plus nine engines and other spares, a flight simulator and auxiliary equipment. Total costs will amount to the equivalent of approximately $ 23,000,000. In addition to the $ 16,800,000 in U.S. currency, the airline will need roughly $ 1,900,000 ($ 5,300,000) for sterling purchases.

Robert J. Clark, Director of European Operations for North American Aviation, Inc., with offices in Geneva, Switzerland.

Wing Commander E. G. Monk (Retd) has been appointed Regional Manager, United Kingdom, for Bendix Aviation Corporation.

Inaugural flight on S.A.S.' Arctic route from Tokyo to Copenhagen: Prince and Princess Mikasa in conversation with Per Kampmann, S.A.S. Vice-President.

● **Scandinavian Airlines System** recorded 274,800,000 tonne-km during the 1955-56 business year (to September 30th, 1956), an increase of 14% over the 241,200,000 tonne-km reported for the previous year. The increase is attributed in part to a better utilization of the existing fleet and in part to the acquisition during the summer of 1956 of six Douglas DC-7Cs and eleven Convair *Metropolitans*. Revenue tonne-km totalled 144,400,000, a gain of 17%. Passenger traffic rose by 20%, freight by 7% and mail by 4%. Load factor for the network as a whole was 52.5%, compared with 51.3% the previous year. The operating year closed with a net profit of 10,400,000 kronor. According to a statement by Per Kampmann, President of the Danish airline D.D.L., one of the three companies forming S.A.S., and Second Vice-Chairman of the S.A.S. Board, S.A.S. may place substantial orders for jet or turboprop passenger aircraft for its medium-haul routes in the near future. No decision has yet been made, however, on the type of aircraft to be bought.

● **Air France** will inaugurate five new through flights between the United States, Europe and the Middle East on April 15th: on Mondays, New York–Boston–Paris–Rome–Tel Aviv; on Tuesdays, New York–Boston–Paris–Rome–Beirut; on Wednesdays, New York–Boston–Paris–Frankfurt–Istanbul–Beirut; on Thursdays, New York–Boston–Paris–Rome, and on Saturdays, New York–Boston–Paris–Istanbul–Beirut. All services will be operated by Lockheed 1049G *Super Constellations*.—During the peak tourist season this year, Air France will have a total of 24 weekly flights between the United States and Europe.

● **Alitalia** has taken delivery of its second Convair 440 *Metropolitan*, and is reported to be modifying its Convair 340s at the Ciampino workshops to improve their efficiency.

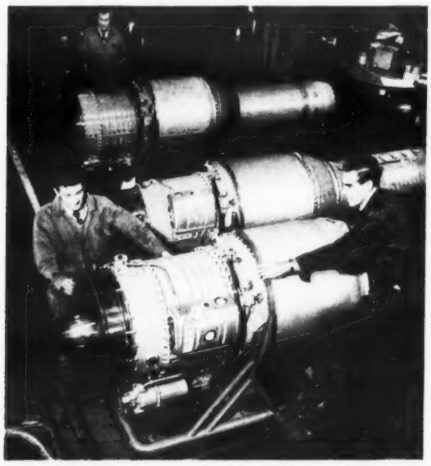
● **Air France** has decided to order seven Boeing 707s (320 version). The company will thus have seventeen 707s by 1960–61. The type of engine to be fitted has not yet been selected.

● **Italian aviation writers** have formed the Unione Giornalistici Aeronautici Italiani. The Committee of seven comprises five journalists and two free-lance-writers. Chairman is Raffaello Guzman (journalist), and Vice-Chairman Lieutenant Colonel Enrico Meille (free-lance). Other members: Alfonso Comasci, Salvatore Caldara, Giorgio Lourier (Interavia Rome), Guido Maisto and Armando Silvestri.

INDUSTRY

● **The British guided weapon programme** now involves more than 400 aircraft firms, the Society of British Aircraft Constructors reveals, and is

Fiat, Turin, has received a number of Bristol *Orpheus B. Or. 3* jet engines (4,850 lbs. thrust) under the N.A.T.O. programme for mutual arms aid and arms development. The engines are to be fitted in the Fiat G. 91.



The F3H-2N *Demon* supersonic fighter (right) and the F-101A and RF-101A *Voodoo* (left) are in large-scale production on dual assembly lines at the Mc Donnell Aircraft Corporation's St. Louis plant. The production facility, only part of which is shown above, was erected to the latest standards at a cost of $ 20,000,000.

coordinated by the Ministry of Supply. The English Electric-Marconi Wireless Telegraph-Napier group is working on a ground-launched anti-aircraft missile, Bristol and Ferranti on a ramjet-powered ground-to-air device, Armstrong Whitworth and General Electric are collaborating on a ship-to-air missile for the Navy, and de Havilland Propellers are evolving an air-to-air weapon. In addition, Fairey, has already produced the *Fireflash* for use by the R.A.F., and a large number of other companies is engaged on power plant, radar and guidance systems.

● **Renewed interest in the Saro Princess** flying boats has been shown in recent months, it is reported from London. At one time the Royal Navy was studying their use as transports or airborne early warning stations. Now the British Aviation Service group of companies has been discussing their purchase, and Rolls-Royce has considered the use of at least one for atomic research. The main problems to be worked out are where B.A.S. would be allowed to operate them, whether they would be suitable for trooping and finally in what condition they are delivered. They are not a commercial proposition in their present state, engineless and cocooned, and it will take a great deal of work to make them fully seaworthy and airworthy. Although an inherently strong machine, the *Princess* was designed and built before the era of water tank tests, etc., and a complete reappraisal of its stress levels has had to be made. A lot of test flying would also be required before certification.–If they were put to use, the flying boats would be powered by six Bristol *Orion* turboprops, in place of the *Proteus* for which they were originally designed.

● **Bristol Aircraft Company** announces receipt of an order from the West German Federal Defence Ministry for the supply of fifty *Sycamore* helicopters for the German armed forces.

● **Douglas Aircraft Company** announces net earnings of $ 33,202,304 for the 1955–56 fiscal year (to November 30th, 1956), which compares with $ 28,215,262 the previous year. Per share earnings were $ 8.96 ($ 7.65). Sales reached the record total of $ 1,073,515,406, compared with $ 867,504,228. In this total, military orders accounted for a full $ 873,000,000, of which sum $ 140,000,000 was for guided missiles. Order backlog at the end of the business year was $ 2,209,049,000, roughly equally divided between military and civil orders. The civil order book covered 31 DC-6As, 66 DC-6Bs, 93 DC-7s and DC-7Bs, 89 DC-7Cs and 122 DC-8s. Military business is divided between the Army, Navy and Air Force and covers the A4D, A3D and F4D naval aircraft, the B-66 light bomber, the C-133 transport and guided missiles.

● **The nuclear engine programme** at the Pratt & Whitney Division of the United Aircraft Corporation has been concentrated in a separate department known as Connecticut Aeronautic Nuclear Engine Laboratory. General Manager of the new operation is Bernard A. Schmickrath, who has been with Pratt & Whitney Aircraft for 19 years. Chief Engineer is Clarence E. Holtsinger. CANEL operations will be conducted at the new Air Force-sponsored facility in Middletown, Connecticut, which the company will occupy this summer.–Pratt & Whitney began work on its nuclear engine project in 1951.

Convair B-58 *Hustler* supersonic bomber with detachable "pod" under the fuselage. The roughly 65-ft. capsule can carry atomic bombs, complete photographic equipment, air-to-air missiles or radar jamming equipment, as required.

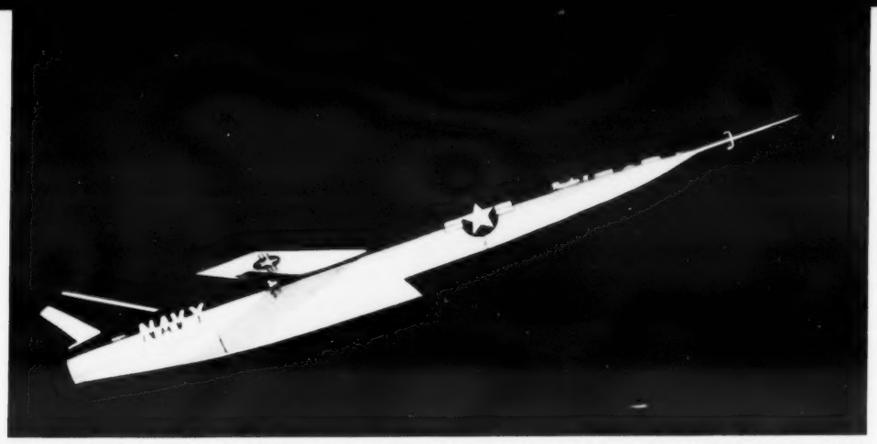
The Spanish CASA 207 *Azor* commercial transport is undergoing certification tests at the Instituto Nacional de Técnica Aeronáutica. The manufacturers plan to apply for C.A.A. certification later.

● **The Finnish Government** has decided to purchase twenty *Gnat Mk. 1* light fighters from Valmet O.Y., who will build them, under licence from Folland Aircraft Ltd., at its Tampere plant. It is expected that, to assist initial production, orders for tooling and the manufacture of several sets of parts, components, etc., will be placed with Folland Aircraft. The announcement follows the Finnish Government's order for twelve *Gnat Mk.1s* placed with Folland in October 1956.

● **Shin Mitsubishi** is examining the possibility of producing the North American F-100D *Super Sabre* for the Japanese Air Force. The company states that it could manufacture three hundred F-100Ds by the end of 1961. However, the Japanese Defence Agency has not yet decided whether the F-100D or the F-104 should be produced in Japan.

Grumman WF-2 radar early warning aircraft. The large "saucer-like" radome necessitated numerous modifications to the TF-1 *Trader* from which the WF-2 is derived. These included changes in the wing and the wing folding mechanism, as well as the fitting of a double tail unit.

The Japanese aviation magazine "Aireview" has suffered the loss of its publisher Jin Imai, 42 (left) and its Editor-in-Chief Kazuo Baba, 30. Both lost their lives when an Air Force C-46 crashed west of Miho base, Provence of Tottori.



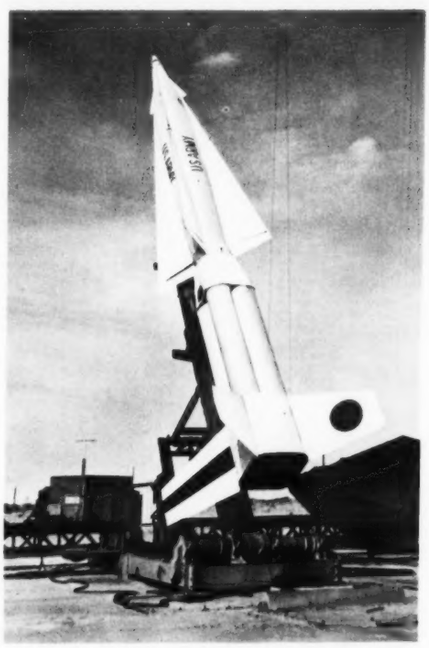
The Chance Vought *Regulus II* missile reaches top speeds of more than Mach 1.5 and is specially designed for operation from submarines and surface craft. Like the *Regulus I*, it is powered by a jet engine, but differs from its predecessor in structure (longer body, stabilization surfaces on fuselage nose, etc.).

MILITARY AFFAIRS

● **The U.S. Defense Department** spent more than $ 4,600,000,000 for aircraft, guided missiles and related production in the six-month period which ended last December 31st. Of this total, about 25% went for guided missiles. The figures include not only production models but also a large part of the money which is being allocated for development and testing. Unpaid obligations during the same period totalled almost $ 1,400,000,000 for missiles and $ 4,740,000,000 for aircraft and related equipment.

● **The Arctic ice island T-3** has been reoccupied by the U.S. Air Force. Five ski-equipped C-47 aircraft landed on the snow-covered island near the North Pole and deposited a seven-man party which will prepare a camp for a scientific group to be stationed there during the International Geophysical Year. Also known as Fletcher's Island, T-3 circles about the North Pole at the rate of one and a half miles a day. It was evacuated by the U.S.A.F. in 1955.

● **The Nautilus,** the U.S. Navy's first nuclear submarine, is being refuelled for the first time this spring, at the Electric Boat Division of General Dynamics Corporation, Groton, Connecticut. This is the first operation of its kind in history, and special equipment and techniques are being used. The present uranium core of the reactor will be removed, and a new core installed. The old core will be sent to Arco, Idaho, for examination and to reclaim unused uranium. An entirely new heat generating machine is being installed. This new core will incorporate important technical advances which will greatly extend the fuel performance, as well as making it simpler, less expensive and more reliable. The improvements have been undergoing tests at the Naval Reactor Facility at Idaho Falls, Idaho, for the past year. A core embodying the new features made a 1,600-hour full power run last summer.–Since it first got underway on January 17th, 1955, the *Nautilus* has travelled over 55,000 miles from power generated by her reactor.



Douglas *Nike Hercules* surface-to-air missile, a development of the *Nike Ajax* already in large-scale service, with greater radius of action, atomic warhead and higher speed.

Bell GAM-63 *Rascal* air-to-surface missile for use aboard jet bombers (B-47, B-52 and B-58). The missile, which is powered by a Bell liquid-propellant motor and weighs roughly 6 tons, is released by the mother aircraft roughly 60 to 150 miles from the target, approaches the latter at a speed corresponding to Mach 1.5 and finally descends at high supersonic speed.

TECHNICAL

● *The Douglas Aircraft Company* is reportedly working on a short take off aircraft. The project is said to bear the designation DC-10.

● A prototype of the *Breguet 1050 Alizé* anti-submarine aircraft has completed a series of simulated deck landings at Istres. Extensive catapult tests are shortly to be made with the Royal Aircraft Establishment's steam catapult installation at Farnborough.

● Shortly after the thrust of the de Havilland *Gyron D.Gy.2* jet engine (20,000 lbs. without reheat, 25,000 lbs. with reheat) was announced for the first time, a spokesman for the Ministry of Supply stated that Government support for the engine would be withdrawn and was not likely to be renewed. De Havilland reports, however, that development will be continued as a private venture.

● After lengthy discussions, the U.S. Air Force has now awarded a contract to an undisclosed value for production of the *Republic F-105 Thunderchief* supersonic fighter. Full-scale production, it is reported, will not get under way until the autumn of 1958.–The award of the F-105 contract probably means that the North American F-107, its rival, will not go into production.

● It is understood that one American and one South American airline are to re-equip their *Convair Liners* in one case and *Constellations* in the other, with *Napier Eland* turboprops.–The *Eland Convair Liner* converted by Napier at Luton is now being equipped with 3,500 h.p. *Eland N.El.6* turboprops, following completion of trials with the earlier 3,000 h.p. engines.

● According to reports in "Sovietskaya Aviatsia", a new *jet trainer* is undergoing flight tests in Yugoslavia, under the designation *KBL.12*. It is a low-wing monoplane with retractable nose-wheel undercarriage, straight wing and horizontal stabilizers, and vertical stabilizer with slight sweep. The two seats are fitted side by side. The relatively thick rear fuselage might suggest that two small jets are fitted side by side. Span 21.3 ft., length 24.6 ft., max. speed approx. 275 knots.

● *Antonov Ukraina* is the name of a Russian 60 to 80-seat medium-haul commercial transport with four turboprops. It is said to have good take-off and landing qualities and be capable of operating from grass runways.–It may probably be assumed that the *Ukraina* is the same as the AN.10 medium range transport already mentioned as a high-wing monoplane with four 4,000 h.p. propeller turbines.

● *Work on Glenn L. Martin's XB-68 supersonic bomber* is reported to have been suspended, though development work on new projects in the same class is to be continued on a limited scale.—The XB-68 tactical bomber was to have had top speeds equivalent to Mach 2 and an operating altitude of well over 50,000 ft.

● In collaboration with Heenan & Froude Ltd., Alvis Ltd. has modernized and enlarged its engine test facilities at Baginton and erected a new type of test bed for helicopter engines, capable of being tilted through an angle of 120°.

● A new type of *weather radar system* has been taken into operation by the German Meteorological Service at Essen. Known as the "Panorama" weather radar, it was developed by the Microwave Institute of the Deutsche Versuchsanstalt für Luftfahrt and permits the exact observation of the formation, movement and dissolution of rain and storm clouds, over an area of 19,300 square miles.

● A rocket-powered small helicopter which can be strapped to the wearer's back has been built by Rotor-Craft Corporation, Glendale, California, under contract to the U. S. Navy. The machine, designated RH-1, has carried a man to an altitude of more than 1,000 ft. and reached speeds of 39 knots.

The Tupolev Bear's Propeller Turbines

by Dipl.-Ing. Ferdinand Brandner

Maschinenfabrik Andritz AG., Graz, Austria

The author, who up to 1945 was one of the Senior engineers in the engine design office of Junkers Flugzeug- und Motorenwerke, Dessau, played a leading part during the war in the development of high-power, liquid-cooled piston engines. Arrested after the German surrender, he finished up in 1948, via the then usual route of prisons and prisoner-of-war camps, at Kuibishev, where the Russians had meanwhile concentrated all the former staff from the Junkers and BMW engine plants in Central Germany, along with wives, children, furniture, machinery and equipment (cf. *Interavia* No. 11, 1950, p. 586 etc.).

After a number of other tasks, Engineer Brandner received an order in 1948 to develop a 6,000 c.v. propeller turbine with the help of the " Junkers Collective ". They were promised that they could return home when they had completed this work. Two years later, however, the Russians came with fresh demands, this time for a 12,000 c.v. turboprop (approx. 11,830 h.p.; 1 h.p. = 1,014 c.v.). Finally, when this assignment had been terminated with a number of test runs at 12,000 c.v., the survivors were permitted to go home, in the summer of 1954. They were replaced by Russian engineers and workers, who thus took over a fully organized development plant.

Today it is known that the 12,000 c.v. engine developed by these German and Austrian engineers powers A.N. Tupolev's four-engine multi-purpose combat aircraft (N.A.T.O. designation *Bear*), which has been in service with the Red Air Force as a bomber, long-range reconnaissance aircraft, anti-submarine aircraft, tanker and transport since 1954, and may also be projected for commercial operations.

The author recently read a paper on Russian turboprop development to the Aerodynamic Institute of the Federal Institute of Technology, Zürich, at the invitation of Professor J. Ackeret. *Editors.*

The development of a propeller turbine for a sea level power of 12,000 c.v. and an altitude power of 8,000 c.v. ordered from my design office in 1950 was by no means the first task of its kind which the Russians had imposed on us. During the first five years of our enforced stay in Kuibishev, we—that is, the some 800 former Junkers and BMW employees assembled into a " collective "—had already had to perform numerous similar tasks, for example:

— the reconstruction of the Junkers Jumo 012 jet engine (6,600 lbs. thrust at 6,100 r.p.m. and an air mass flow of 132 lbs./sec.).

— the construction of a propeller turbine (type 022) for a sea-level power of 5,700 c.v. plus 1,320 lbs. residual thrust (7,650 r.p.m.; air mass flow 66 lbs./sec.; consumption 0.53 lbs./c.v. hr.).

— the construction of a coupled turboprop (two 022s) of roughly double the power.

Our morale was kept up only by constant promises that we could go home " soon ".

The 012 jet engine ran as early as 1948, but then development was broken off. The 022 propeller turbine came out in 1950. It reached the required power, but we heard nothing about its later fate, whether it went into production, etc. The double engine, which we had tackled very reluctantly, was a failure, though no blame was attached to us.

Finally, after five years of extremely hard work, we were given our fourth major task, fortunately the last: to develop a superpowerful turboprop for a giant four-engine aircraft being designed by A. N. Tupolev.

*

We were given a *time limit of three months* within which to design this engine. By employing some hundred designers, we managed to keep within this time limit. I know that nobody in Western Europe will believe that it could be done. Yet in the Russian twilight of fear and hope it is possible... a fact to which we are the living witnesses.

The new engine was designated " *Type K* " apparently in honour of Engineer Kutsnetsov, the Russian director of the Kuibishev development plant, who was a man of high intelligence and wide technical knowledge. The general structure of the K engine is shown in *fig. 1*; leading data and performance figures are given below.

Propeller turbine with 14-stage axial compressor, 5-stage turbine and 2-stage differential gear (reduction ratio 1 : 11) on a single shaft, designed for an operating altitude of 36,000 ft. and an optimum flying speed of 485 knots.

Shaft power at 36,000 ft.	8,000 c.v.
Shaft power at sea level	12,000 c.v. (constant up to 26,000 ft.)
Residual thrust at sea level	2,640 lbs.
Rev. speed	8,250 r.p.m.
Air mass flow	136 lbs./sec.
Gas temperature in front of turbine	
at 36,000 ft.	1,150 ° K
at sea level	930 ° K
Compression ratio	
at 36,000 ft.	1: 13
at sea level	1: 9.5
Design fuel consumption at 36,000 ft., 485 knots flying speed	0.35 lbs./e.c.v. hr.
Measured consumption at sea level	0.57 lbs./e.c.v. hr.
Overall diameter of engine	45.27 ins.
Length	236.2 ins.
Weight without propeller	5,070 lbs.

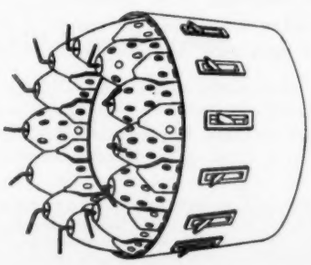
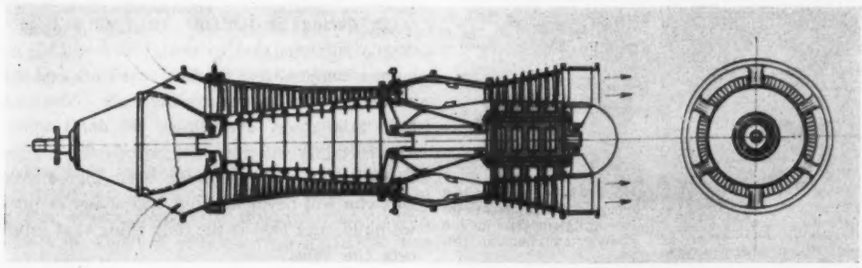


Fig. 3: Annular combustion chamber of the K engine, with twelve primary burner heads.

Fig. 1: Section drawing of the Germano-Russian Type K turboprop engine, for a shaft power of 12,000 c.v. (at sea level) plus 2,640 lbs. residual thrust.



The engine was to drive two four-blade contra-rotating propellers of Russian design, with a diameter of 16.4 ft. and operating speeds of approx. 750 r.p.m.

Fitted with a specially designed 65 h.p. turbo-starter (36,000 r.p.m.) with radial compressor, spiral combustion chamber, single-stage turbine and differential gear. Air bleed valves on the compressor and adjustable first-stage stator blades facilitated starting.

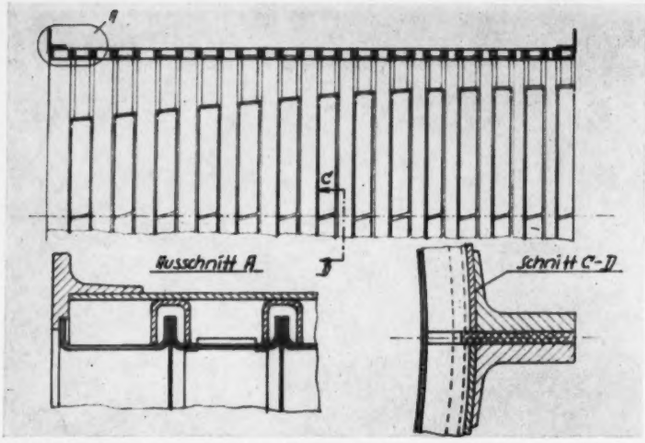


Fig. 2: Compressor housing for the K engine, welded from 0.078-inch steel sheet and U profiles.

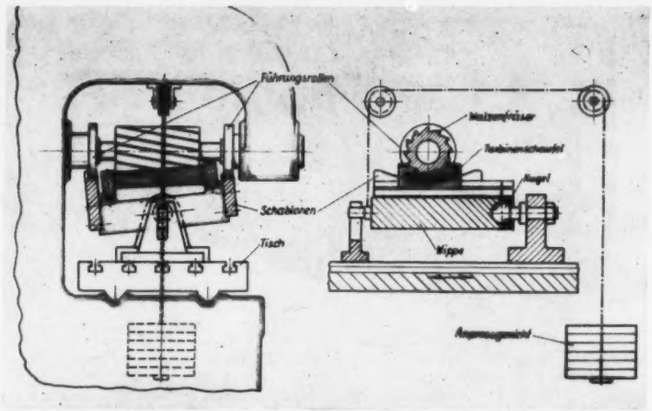


Fig. 4: Milling the turbine blades for the K engine on the " cradle " developed by Professor Bredendick (Dresden Institute of Technology): turning simultaneously with the milling cutter are two guide rollers, against which the weight-loaded cradle rests via templates at either end.

Structural details

Compressor : 14-stage, designed for a maximum circumference speed of 1,063 ft./sec. and a compression ratio of 1:13 ; the compressor has an efficiency of 0.86. Hub ratio (d/D) of the first stage is 0.453, mean intake speed 574 ft./sec., exit speed 344 ft./sec. External rotor diameter, first stage 29.5 ins., decreasing progressively to 24.9 ins. at sixth stage. Behind this stage constant diameter.

The two-part casing *(fig. 2)* is welded of 0.079-inch steel sheet and stiffened by U-shaped sheet rings. These rings also support the rotor blade casing rings and the outer stator vane rings. The stator vanes (of St.60 steel) are inserted in the latter and welded to the rings. At the inner end of the stator vanes of each stage there is another U-shaped support ring. This complicated stator is annealed in one piece after welding, before being separated into two halves.

The compressor rotor consists of eight steel rings screwed together by means of flanges, into a rigid tube, and six discs between the rings *(fig. 1)*. The rotor blades—also of steel—are inserted in these discs and rings by means of swallow-tail feet and secured by pins. The rotor is mounted on roller bearings (front) and ball bearings (rear).

Combustion chamber : As revealed by *fig. 3*, the combustion chamber consists of a *primary portion* (twelve heads, each with a 2-stage injection nozzle and swirlbaffle) and a cylindrical *secondary portion*. It is welded of pressed scale-free steel sheet 0.039 to 0.059 ins. thick, subsequently annealed, and weighs roughly 100 lbs. ready for installation. Air intake speed is 164 ft./sec., exhaust speed of the hot gases 426 ft./sec. The chamber's combustion efficiency is 98.5 %, its operating life 300 to 500 hours.

Turbine : In five stages, with a hub ratio (d/D) of 0.85 for the first stage, the turbine has an optimum efficiency of 0.93. — This can, of course, be achieved only with very small clearance ; for this reason we lined the turbine blade shroud rings with graphite or sintered metal, to avoid damage should the blade tips graze them.

Like the compressor stator, the turbine stator is also of welded construction. The blades, of a cast cobalt alloy, are supported by U-shaped outer and inner rings of heat-resistant steel sheet 0.078 in. thick. In the first stage they are inserted loose in both rings, while in the other four stages they are welded to the outer rings.

The turbine blades and discs, for which Nimonic alloys have been available in the Soviet Union since 1953, were milled out of austenitic chrome-nickel-manganese-vanadium steel (of high C content) for the prototype engines, then polished to a mirror surface and nickel-plated. For the milling process we used the " cradle " device shown in *fig. 4*.

Other interesting points are that titanium was used experimentally for compressor discs as early as 1953, and that extensive research has been made in the field of turbine blade cooling, with the object of raising gas temperature to 1,400 ° K.

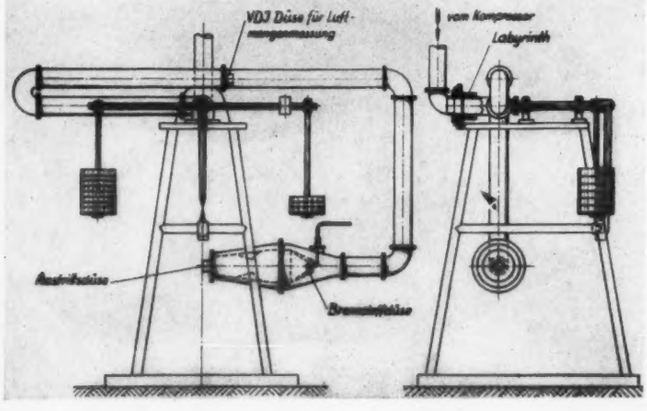


Fig. 5: Diagram of the test bed erected at Kuibishev for accurately measuring the combustion chamber efficiency.

Later development . . .?

In the above I have described the technical situation of the K engine in 1954. We do not know what structural modifications the Russians made during production. In 1949 a Soviet deputy minister said to me : " You will all go home when you have finished your work and the engine is in production somewhere. You can then talk about everything, we don't mind. You certainly will not want to copy the engine. We all cook with the same basic ingredients. But you will never find out how many engines we build, and that is the only thing that interests the West."

The Boucher Fog Dispersal System

The following report is based on technical information supplied by physicist R. M. G. Boucher. The fog dispersal system described is protected by French and other patents and is being tested in four countries, in France by Société d'Applications Supersoniques, Paris; in Britain by Aerojet Ltd., London; in Sweden by Aerojet Venturi AB, Växjö; and in the United States by Gulton Industries, Metuchen, New Jersey. Editors.

Despite the constant improvement in radio-electric instrument landing procedures, landings in bad weather are still one of the main problems in flying. In fact, some airports refuse to accept aircraft in foggy weather, not because landings are impossible, but because each would take too long for the necessary frequency to be maintained.

In view of the importance of this problem, a great many attempts have been made to find a satisfactory method of dispersing fog. The methods proposed fall into three groups: thermal (Fido), acoustic, physico-chemical.

Physicist R. M. G. Boucher has developed a further system, which combines the acoustic with the physico-chemical method.

Fog dispersal by acoustically-provoked coagulation

The behaviour of the water droplets composing a fog in a powerful sound field is extremely complicated. The basic principles of this form of precipitation are described in brief below.

Firstly, it has been found that smaller particles of a solution (dust, fog, smoke, etc.) follow the oscillations of the gaseous solvent under the influence of a sound field more easily than larger particles. The varying mobility of the water droplets leads to collisions, or " orthokinetic coagulation ". Thus acoustic coagulation appears to be produced in large measure by collisions between smaller particles with a large oscillation amplitude, and larger particles with a small oscillation amplitude.

This process clearly reveals that the coagulation of water droplets depends on the sound frequency. Other important factors are the size of the particles and their distribution in the solvent. A sound frequency which would be unsuitable for either small or large particles alone may still create a high degree of coagulation when both large and small particles are present simultaneously. Hence the value of using several frequencies (frequency spectrum), each of which is adapted to a particular size of particle.

The coagulation process described above is by no means, however, the only (and in some cases not even the predominant) process which occurs in acoustically-provoked precipitation. Other examples are dynamic pressure, eddy phenomena, electric surface charges, turbulence, etc.

Until a few years ago, attempts at artificial fog dispersal through acoustic oscillations encountered two obstacles :

1. the absence of high-power sound and ultrasonic generators with an adjustable frequency spectrum ;

2. the high costs (initial and operating) of all promising acoustic systems.

Recent developments in the field of acoustics and the results of investigations into the behaviour of aerosols have greatly improved the prospects of solving the difficult problem of bad weather landings. The R. M. G. Boucher system appears to overcome the first difficulty, while the second should be solved by the combination of the acoustic with the physico-chemical method of fog dispersal.

The R.B. whistle unit

This ultrasonic generator *(fig. 1)*, which contains no moving parts, was specially designed for permanent use at airports. It is extremely rugged and small in size (height 13.8 ins., diameter 9.8 ins.), and a characteristic feature is that the power of the acoustic signal is entirely independent of the frequency. Through the combination of several special whistles inside a resonance chamber, it is possible to produce one or more frequencies, as required, with an efficiency of 20 %. For this purpose either gas or compressed air is used (35.6 to 85.4 p.s.i.).

Fig. 1 — The R.B. whistle unit (multisifflets).

During 1956 R. M. G. Boucher carried out fog coagulation tests with this sound generator in Electricité de France's test chamber at Châtillon. Because of the dimensions of this chamber ($39 \times 42.5 \times 55.5$ ft.) and the relatively low acoustic power of 500 W, resonance phenomena had very little effect on the results. The test conditions therefore largely resembled operating conditions in the open, in dense fog and in still air.

Two dense solutions (several grammes of water per cubic metre) were tried, one with droplets of 4 μ to 20 μ, and the other composed chiefly of droplets of about 1 micron. The behaviour of the fog, produced by pneumatic atomizers, was accurately observed as a function of time. After 15 minutes the coarser fog (closely resembling natural fog with a particle size of 4 μ to 8 μ) had been entirely dissipated under the influence of a sound frequency of 9.5 kc/s, whereas an experiment with a frequency of 33 kc/s and the same sound intensity had negative results. For the finer fog the results were reversed. The 33 kc/s field accelerated precipitation, while 9.5 kc/s had no effect. Calculations showed that an economic effect with whistle units spaced at intervals of 82 ft. along the runway can be obtained only in still air. Even then, the effect is merely to accelerate coagulation (up to an altitude of 65 ft.), not to provoke immediate precipitation. Better results could be obtained by increasing the power of the sound generators, but this would be too costly, since sound intensity is inversely proportional to the square of the distance.

The R.M.G. Boucher system

Coagulation can also be achieved by creating a saturation pressure gradient between the colloidal particles and other particles distributed through the solution. The latter particles (ice crystals) can form automatically in certain types of fog (negative fog in the sub-cooled condition below —5° C).

This is the principle on which Harry Langdon based the system he applied at San Diego Airport, California, during the post-war years. Solutions of hygroscopic compounds (aluminium sulphate, calcium chloride) were pulverized in a combustion chamber at 700° C, and the micro-crystals thus obtained were blown into the fog layer. If this method is to be used to provoke precipitation of a *fog of positive temperature*, the micro-crystals must be ejected high enough to produce a substantial enlargement of the hygroscopic nuclei. To achieve total dispersal the nuclei must be distilled rapidly to a size of roughly 20 μ, while still at a sufficient height to unite with the water droplets by simple mechanical collisions during fall. Calculations

reveal that the condensation nuclei would have to be projected to a height of many hundred feet, which would require too much power.

On the other hand if, after the initial phase and when the particles have reached a size of 10 to 20 μ, they are attacked by an ultrasonic field, the process of coagulation is greatly accelerated, as described above. This is the basic principle of the R. M. G. Boucher system, in which acoustically provoked coagulation is superimposed on the natural combination of water droplets (through collisions) in the final phase. In this way it is not necessary to project the hygroscopic condensation nuclei higher than some hundred feet. The ultrasonic field thus becomes a kind of " coagulation accelerator ".

One method of setting up the R. M. G. Boucher system along a runway is shown in *fig. 2*. The main feature is the alternation of ultrasonic generators and condensation nuclei burners. The hygroscopic nuclei follow the thermal convection flow and thus enter the sphere of influence of the sound field. By installing the system along both sides of the runway it is possible to produce additional phenomena, such as interference between two facing generators.

In the case of a *fog of negative temperature*, the droplets are in a sub-cooled state. As is known, the vapour pressure surrounding a metastable body is always higher than that around the same body in stable form at the same temperature. Thus if ice crystals are introduced, as coalescence nuclei, into a sub-cooled fog of this kind, they provoke rapid coagulation, assisted by the return of the water droplets to a stable condition. The installation shown in *fig. 2* is also suitable for these operating conditions. The atomizers are so designed that, if necessary, they can produce nuclei of silver iodide and blow them into the fog by means of a current of cold air. Incidentally, the acoustic oscillations themselves also play an important part in stabilizing sub-cooled solutions.

In addition to these applications, the system can be used to eject carbon dioxide snow, propane, etc., or electricized particles in combination with ultrasonics.

To sum up, it can be said that, in the case of negative fog, coagulation can be substantially accelerated through the combination of conventional systems and the ultrasonic technique.

Economic aspects of the problem

The following estimate of the cost of equipping a 3,300-ft. runway with thirty R.B.12 whistle units and thirty atomizers on either side has been prepared by Société d'Applications Supersoniques. Each atomizer consumes approximately 7 kW (ventilator and burner) or 1¼ to 2¼ gallons of fuel per hour. An electric compressor to supply 30 sound generators consumes approx. 250 kW. Ignoring the very low cost of atomizing the hygroscopic solutions, hourly operating costs will amount to roughly 100 to 120 Swiss francs.

Fig. 2 — Diagram of the R.M.G. Boucher system of artificial fog dispersal on runways.

1 Runway
2 Atomizer (burner and spray)
3 R.B. whistle unit
4 Compressed air lead
5 Compressor
6 Electric lead
7 Visibility measuring unit
8 Fuel conduit

These figures will vary between certain limits, depending on the type of fog ; it would seem, however, that 600 Swiss francs per hour would be the upper limit.

Initial costs of the installation would be in the region of 500,000 Swiss francs.

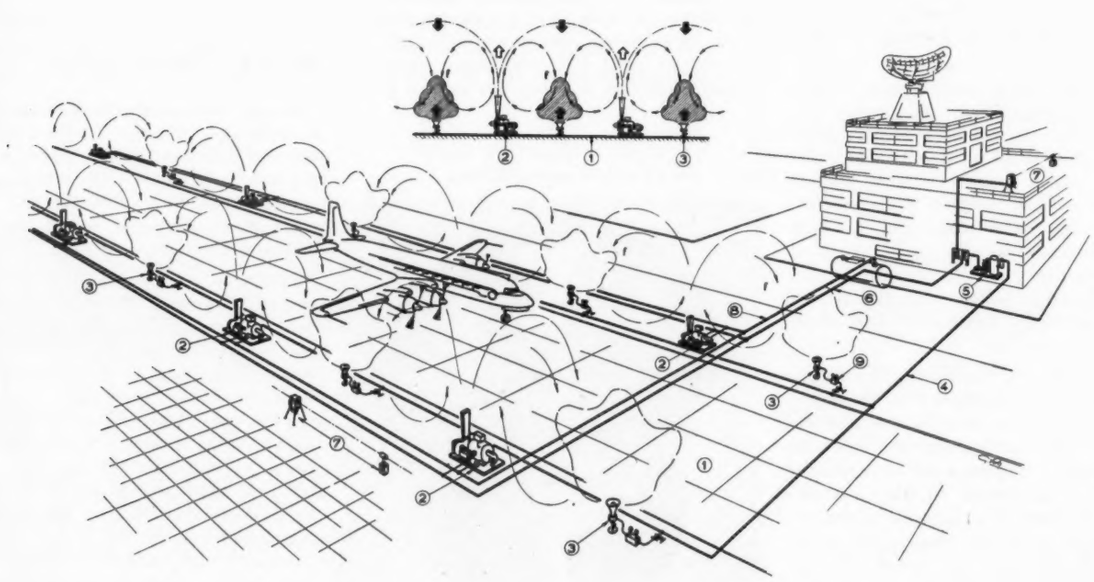
Compared with the cost of thermal systems of fog dispersal, these figures represent a real economy. An earlier Fido installation cost roughly 5,000 Swiss francs per minute during the first 15 minutes of operation and approximately 2,500 Swiss francs for every minute afterwards. More recent installations (R.A.E., Farnborough), however, have reduced operating costs to roughly 300 Swiss francs per minute. Estimated initial cost of installing such a system at London Airport is 4,000,000 Swiss francs.

Finally, the R. M. G. Boucher system can be operated from the control tower *(fig. 2)*, or the meteorologists responsible for ascertaining the type of fog present could also take over control of the quantity of solution to be atomized and of the compressed air. The efficiency of the system is checked by means of visibility measuring equipment.

Height of the whistle unit, including base, is 2 ft., and that of the atomizer roughly 5 ft.

The ultrasonic transmissions have virtually no physiological effect on humans because of the powerful damping of the oscillations in this kind of weather. The audible frequency range produces slightly unpleasant sensations in the immediate vicinity of the generators (roughly 50 ft.).

A weak point of the new system is the sharp drop in efficiency in the presence of a horizontal wind.



Air Transport Inventory for the Jet Age

The following data supplied by the Air Research Bureau illustrate the air fleet situation of European airline members in preparation for the coming jet age.

The standard of the equipment now used in European air transport, the A.R.B. points out, is very similar to that of U.S. airlines. Although during the immediate post-war period non-pressurized aircraft were the rule, these now represent only a small percentage of airline fleets. In 1954, roughly 25% of the kilometres flown on European services were performed by aircraft without pressure cabins, but by 1956 this figure had dropped to 19%.

Share of aircraft without and with pressure cabins in total kilometres flown in 1955

	U. S. domestic *		A. R. B. companies	
	km (mils.)	share of total	km (mils.)	share of total
Twin-engined				
DC-3 and other non-pressurized	58	7.7%	10	12 %
Convair 240/340 and other pressurized	187	24.9%	26.5	31.7%
Four-engined				
DC-4 (non-pressurized)	77	10.2%	6.3	7.5%
Constellation	103	13.7%	3.1	3.7%
DC-6/6B	228	30.3%	18.1	21.7%
Other pressurized	97	12.9%	0.3	0.4%
Viscount	22	0.3%	19.2	23.0%
Total	752	100%	83.5	100%
Share of non-pressurized		17.9%		19.5%

* Excluding local airlines

Orders for turbine-powered airliners mean that the European airlines' capacity will increase by 160% compared with 1956 when these new aircraft come into service, while U.S. airlines' capacity will rise by 110%. In 1961 more than half the Europeans' traffic will be performed by turboprop and jet aircraft, while the Americans will continue to rely on piston-engine types for a major part of their total.

Aircraft on order at the end of 1956

	U.S. airlines	European airlines
DC-8	86	26
Boeing 707	95	32
Comet 4	14	19
Caravelle	—	12
Convair 880	40	—
Britannia	5	33
Electra	116	12
Vanguard	—	20
Viscount 800	20	63
Viscount 700	43	14
Fokker F-27	12	23
DC-7/7-C	149	48
L-1649	24	19
L-1049	16	11
DC-6	52	—
Convair 440	28	30
Total	700	362

The European re-equipment programme need, therefore, fear no comparison with the American. Moreover, a large proportion of the medium-range types will be supplied by the European aircraft industry, namely the *Viscount, Vanguard, Caravelle* and *Friendship*.

The accompanying brief survey of the A.R.B. companies' 1956 traffic figures supplements the above data.

Company	Employees	FLEET AT END OF 1956 In service	FLEET AT END OF 1956 Orders and options	Passengers	Freight (tonne-km)	Load factor
Aer Lingus [1]	1 768	4 **Viscount 700** 13 DC-3 2 Bristol 170	3 **Viscount 800** 5 **Friendship**	400 000	16 000 000	67 %
Air France	17 878	20 **Super Constellation** 17 **Constellation** 11 **Viscount** 12 **Provence** 21 DC-4 (C-54) 41 DC-3	12 **Super Constellation** 10 Boeing 707 (+8 Opt.) 12 **Caravelle** (+13 Opt.)	2 332 000	74 000 000	71 %
Alitalia	1 110	6 DC-6B 4 Convair 340	2 Convair 440 4 DC-7C	.	25 500 000	55.6%
BEA-British European Airways [3]	10 374	19 **Elizabethan** 27 **Viscount 700** 46 DC-3 6 Others 7 Helicopters	38 **Viscount 800** (+7 Opt.) 12 **Viscount 840** (Opt.) 20 **Vanguard**	2 437 000	20 900 000	64.7%
Deutsche Lufthansa	3 500	8 **Super Constellation** 4 Convair 340 3 DC-3	4 Boeing 707 4 **Super Constellation** 2 Convair 440 7 **Viscount 814**	228 600	4 000 000	52 %
Flugfelag Islands	210	2 DC-4 4 DC-3 2 **Catalina** 1 Grumman **Goose**	1 **Viscount**	70 020	.	.
Iberia	2 520	3 **Super Constellation** 6 DC-4 17 DC-3 4 Bristol 170	5 Convair 440 2 **Super Constellation**	673 300	.	68.4%
KLM-Royal Dutch Airlines	15 863	14 DC-6 (+A, B) 6 DC-4 10 **Constellation** 18 **Super Constellation** 21 Convair 240, 340 15 DC-3 2 Others	10 DC-7C 8 DC-8 9 **Viscount** 12 **Electra** 2 **Friendship**	822 000	63 100 000	60.5%
Sabena	6 981	14 DC-6 (+B, C) 2 DC-7C 8 DC-4 12 Convair 440 4 Convair 240 28 DC-3 (C-47) 4 Helicopters	7 DC-7C 4 Boeing 707 4 Helicopters	527 700	27 600 000	57.2%
SAS-Scandinavian Airlines System [3]	9 430	26 DC-6 (+B) 6 DC-7 4 DC-4 11 Convair 440 10 DC-3 8 **Scandia**	8 DC-7C 7 DC-8 5 Convair 440	1 179 000	.	52.5%
Swissair	3 881	2 DC-7C 6 DC-6B 3 DC-4 9 DC-3 9 Convair 240, 440	2 DC-7C 3 DC-8 4 Convair 440	773 900	11 800 000	66.5%

[1] 1955-56 business year [2] Load factor for the 1955-56 business year [3] 1955-56 business year (to September 30th, 1956)

Book Reviews

The Soviet Army.—Edited by Captain B. H. Liddell Hart. —Weidenfeld Nicolson, 7 Cork Street, London W.1, 1956 (English, 480 pages, 36s.).

This timely book, edited by the best-known British military analyst, Captain B. H. Liddell Hart, is a symposium of 39 chapters contributed by British, French, German, Russian and U.S. experts. At a moment when Western minds are still vividly preoccupied with recent events in Central Europe, which showed that the Soviet can deploy conventional weapons in unprecedented strength at short notice, the book traces the evolution of the Red Army from 1918 to 1955 and also tries to probe into the future of the great Russian " steam-roller ". Quite naturally it places much emphasis on the development of the Soviet armoured forces, beginning with the lessons the Red " volunteers " brought back from the Spanish Civil War where tanks were employed only in co-operation with other arms. These lessons were brutally modified by the German Blitzkrieg against Poland in 1939 and even more so by the Nazi armoured campaign against Russia from 1941 to 1943.

The book seems to indicate that even in today's age of the atomic weapon the Soviet General Staff is still relying on a set—necessarily modified—of armour tactics. The independent use of large tank formations, not immediately supported by conventional infantry and artillery, has become the official concept. The safest and surest method of attack in the nuclear battlefield is today considered to be the swift armoured thrust, prepared by atomic strikes and exploited to the maximum by mechanized forces such as armoured personnel carriers and self-propelled artillery.

As regards the air arm, " The Soviet Army " tells us that an Air Army is attached to each Army Group. This Air Army will consist of four Air Divisions—fighter, ground attack, reconnaissance and bombardment—each with 120 to 240 aircraft, depending upon the type of mission assigned to it.

The long-range Air Force, controlled directly by Defence Minister Marshal Zhukov, constitutes the Kremlin's nuclear deterrent (like the U.S. Strategic Air Command, which reports direct to the U.S. Chiefs of Staff). But the Soviet General Staff does not accept the U.S. premise that any World War III will open with all-out atomic warfare—hence the Soviet emphasis on A-weapon-supported conventional weapons. In the words of one of the contributors to the book, even atomic surprise attack would be " too great a gamble for the cold-eyed men in the Kremlin whose fundamental ideology tells them that time is on their side. " Consequently they are using their thermonuclear potential in the form of the *Bison* and other intercontinental bomber types mainly as " nuclear blackmail " to disrupt opposing coalitions.

P.A.B.

Heller als tausend Sonnen.—By Robert Jungk.—Alfred Scherz Verlag, Berne, 1956 (German: 368 pages, price Fr. 16.80).

The author of the earlier widely read book on America's " omnipotence and impotence " *(Die Zukunft hat schon begonnen)* here describes the tragedy of the American atomic scientists, the men who set out to proclaim a new philosophy of nature and who were ultimately obliged to build more and more powerful weapons of destruction: A bombs, H bombs, FFF bombs, etc. Originally atomic scientists formed one big family, but racial persecution in Nazi Germany and the American-Soviet rivalry split them into three groups, each suspicious of the others. Jungk explains why the international group in the United States (Oppenheimer, Teller, Fermi and many others) devoted itself to producing atomic weapons, and why the Germans (Hahn, Heisenberg, von Weizsäcker) did not. He describes the atomic arms race between the United States and the Soviet Union, which began after the Yalta Conference—incidentally with the interesting revelation that the Russian atomic weapons were built *against* the opposition of Kapitza, Rutherford's favourite pupil (p. 258). Kapitza is quoted as having exclaimed in 1956; " Always to mention atomic energy and atomic bombs in the same breath is just as ridiculous as to consider electricity chiefly in connection with its use in the electric chair." It is therefore to be hoped that, despite previous signs to the contrary, reason will retain the upper hand among thinking men and it will one day be possible to write an equally gripping book on the blessings of peaceful atomic energy.

Ri.

Post-War International Civil Aviation Policy and the Law of the Air.— By Dr. H. A. Wassenbergh. Martinus Nijhoff, The Hague, 1957 (English, 180 pages, price Fl. 11.50).

The value of international conventions is measured by what the contracting States make out of them in practical application. The author here examines the fate of the 1944 Chicago Convention, the Magna Carta of international air transport, during the past twelve years. And he comes to the regrettable—and doubtless correct—conclusion that very little remains of the Convention's basic principle, namely the right of all States to freedom of air transport. Nationalistic narrow-mindedness has led to a serious over-valuation of sovereign rights, to restrictive measures and hence to the hopelessly entangled system of bilateral air transport agreements, which has become less a cure than a symptom of sickness. Echoing Albert Plesman, to whose memory the book is dedicated, the author calls on the airfaring nations to work purposefully towards a multilateral agreement on air transport freedoms. Incidentally, time is running short. Unless courageous steps are taken soon, the jet age will inevitably lead to the bankruptcy of present civil aviation policies.

He.

Transport-Betriebswirtschaft im Grundriss.—By Professor Leopold L. Illetschko.—Springer-Verlag, Vienna, 1957 (German, 210 pages, price 19.50 Swiss francs).

The author, head of the Institute of Transport Economy at the Vienna School of World Commerce, modestly claims that his sole purpose was to write an introductory guide to the study of transport economics. In reality, however, what he has produced is a complete treatise on the subject. Far from being a mere compilation of earlier writings, the book is an original, critical presentation of the subject-matter which will be found stimulating by all transport economists. Even air transport economists will read it with profit, although air transport is only one of the many forms of transport discussed. Representative chapter headings include " Nationalization ", " Operating without Subsidies ", " Community Value and Subsidies ", " Price Policies and Service ", etc.

He.

Famous Fighters of the Second World War.—By William Green.—MacDonald & Co. (Publishers) Ltd., 16 Maddox Street, London, W.1, 1956 (English, 128 pages, profusely illustrated by photographs and drawings, 18s.)—

The World's Fighting Planes.—By William Green and Gerald Pollinger.—MacDonald & Co. (Publishers) Ltd., London, W.1, 1957 (English, 240 pages, fully illustrated by photographs and drawings, 15s.)—

The Aeroplane Pictorial Review.—By the Staff of " The Aeroplane ".—Temple Press Ltd., Bowling Green Lane, London, E.C.1, 1956 (English, 126 pages, illustrated, 7s. 6d.).—

Together the three books form an " aircraft spotter's orgy." *Famous Fighters* describes the evolution of the major fighter aircraft types which decisively influenced the air war from 1939 to 1945. It provides details of the aircraft's design history, an excellent three-view drawing of each basic fighter type, illustrating the successive design variants during the type's combat life. The Messerschmitt Me 109 is shown in 14 different versions, the Hawker *Hurricane* in six, the Supermarine *Spitfire* in ten (only; why ?), the Focke-Wulf Fw 190 in sixteen, the Republic P-47 *Thunderbolt* in nine, the North American P-51 *Mustang* in seven, the Mitsubishi *Zero-Sen* in nine, the Messerschmitt Me 262 twin-jet in ten. Altogether 17 basic types are dissected and illustrated.

Fighter Planes, a second and revised edition, is a handy pocket-size duplication of a more famous publication of the same kind, but it concentrates on military aircraft only (including transports and trainers). In brief paragraphs it provides a photograph, three-view drawing and principal specifications of the aircraft which form the equipment of the world's air forces today. It includes a relatively complete section on Soviet military aircraft, but part of this—especially the information concerning prototype fighters and experimental aircraft—seems highly speculative.

Pictorial Review is exactly what its title says; a collection of photographs of aircraft and aeronautical events illustrating the evolution of commercial and military aviation over the past year or so. The volume, set out in loose chapters, according to categories of aeronautical equipment, is attractive to this reviewer because for once it ignores aircraft specifications and concentrates more on the aesthetics of flying and on the people who make aviation work.

P.A.B.

Les Hélicoptères.—By Henry Beaubois.—Presses Universitaires de France, Paris, 1956 (French, 126 pages, illustrations).

This little book, published in the popular " Que sais-je ? " series, discusses the various aspects of rotary-wing aircraft in adequate detail. One chapter is devoted to the history of this branch of flying, where the layman will learn that since the days of Leonardo da Vinci the problem has been studied by a legion of experimenters, but that no satisfactory solution was found until shortly before World War II. This war, like World War I, greatly stimulated aeronautical progress, and the helicopter emerged from it as an " everyday " transport vehicle. The sections on the principles, engineering and pilotage of helicopters present all the basic facts that the curious general reader will seek. Finally, chapters on the capabilities and applications of rotary-wing aircraft, and the characteristics of heliports are followed by an outline of future prospects.

La.

Les avions modernes (Tome I—La cellule: Tome II—Les moteurs): second edition.—By Henry Lancy.—Girardot & Cie, Paris, 1956 (French, 264 and 334 pages, illustrations).

Two volumes devoted to the basic fields of aeronautical engineering (airframes and engines) presented in readily assimilable form with a wealth of welcome detail. Although the second edition has been revised and enlarged, the book tends at times to become retrospective. It is nevertheless highly instructive, despite one or two minor errors (for example, Mignet's *Pou du Ciel* did not make use of warping, or of ailerons for that matter).

La.

Best Flying Stories.—Edited by J. W. R. Taylor.—Faber & Faber, 24 Russell Square, London. (English, 315 pages, 15s.).

In this second collection of " Best Flying Stories " the Editor, one of the most popular British aviation authors himself, has again succeeded in assembling a most readable and entertaining series of descriptions of various aspects of flying. In time they range from the early days of flying through World Wars I and II to the modern age of supersonics, while the subjects include the experiences of the early aircraft builders, air mail pioneers, polar explorers, fighter and bomber pilots, gliding, etc. Among the 18 authors are Igor I. Sikorsky, who tells us about the flight of his giant aircraft " Ilia Mourometz " from Petrograd to Kiev in 1914 (" I put on my warm overcoat and went to the upper bridge of the ship "); Antoine De St.-Exupéry, Quentin Reynolds, H. E. Bates, Major-General Walter Dornberger, Pierre Clostermann, Wolfgang Langewiesche, Jacqueline Cochran and Hanna Reitsch.—A book for the tired aviation enthusiast.—

P.A.B.

Leçons d'anglais scientifique et technique.—By P. Nashlin.—Dunod, Paris, 1956 (English and French, 391 pages).

The author here sets out to initiate his readers into the vast and complex terminology of scientific and technical English. For this purpose he explores the most important sectors of modern science and technology in 32 lessons, giving for each subject a text and its translation, and adding notes and explanations on the most useful terms. A special phonetic code is used to indicate the pronunciation of English words. As a textbook, this publication will render valuable services: it would be even more valuable as a reference book if the author had added an alphabetical glossary of English terms with the page numbers on which they are introduced.

La.

Résistance de l'air et théorie cinétique des gaz à très haute altitude—Astronautique et satellites artificiels.— By S. Travers.—Eyrolles, Paris, 1956 (French, 220 pages, 45 figures, price 2,000 French francs).

The author here explores, in preparation for the International Geophysical Year and the advent of space travel, the limits of the earth's atmosphere, where cosmic rays, aurora borealis and meteors have already been recognized as the principal cosmogonic problems.

Though at times the author's remarks, based throughout on the kinetic theory of gases, verge on the metaphysical, they are nonetheless capable of practical application, since they also deal with the conditions for launching the first artificial satellite.

The portions of the book devoted to the ballistics of the future, general relativity and the evolution of the universe are (relatively) simple, without excessively obscure formulæ.

Mathematicians who might be put off by the author's speculative tone will be reassured by the extensive bibliography, the mathematical tables of the functions of probability enabling the most accurate calculations to be made, the appendices on the approximate calculations of Maxwell distribution, etc., in which a large number of problems of interest to present-day aviators and artillery men, as well as future astronauts, are presented and, in some cases, solved.

La.

Radar-Technik. — By H.-J. Fischer. — Fachbuchverlag Leipzig, 1956 (German; X+464 pages; price DM 39.—).

This book systematically presents the basic principles of radar technology for engineers and technicians, with special reference to the structural and practical side. The many pictures, drawings and circuit diagrams provide the designer with valuable indications and the student with a graphic presentation of the subject matter. The unusually extensive bibliography includes a large number of Russian sources.

Na.

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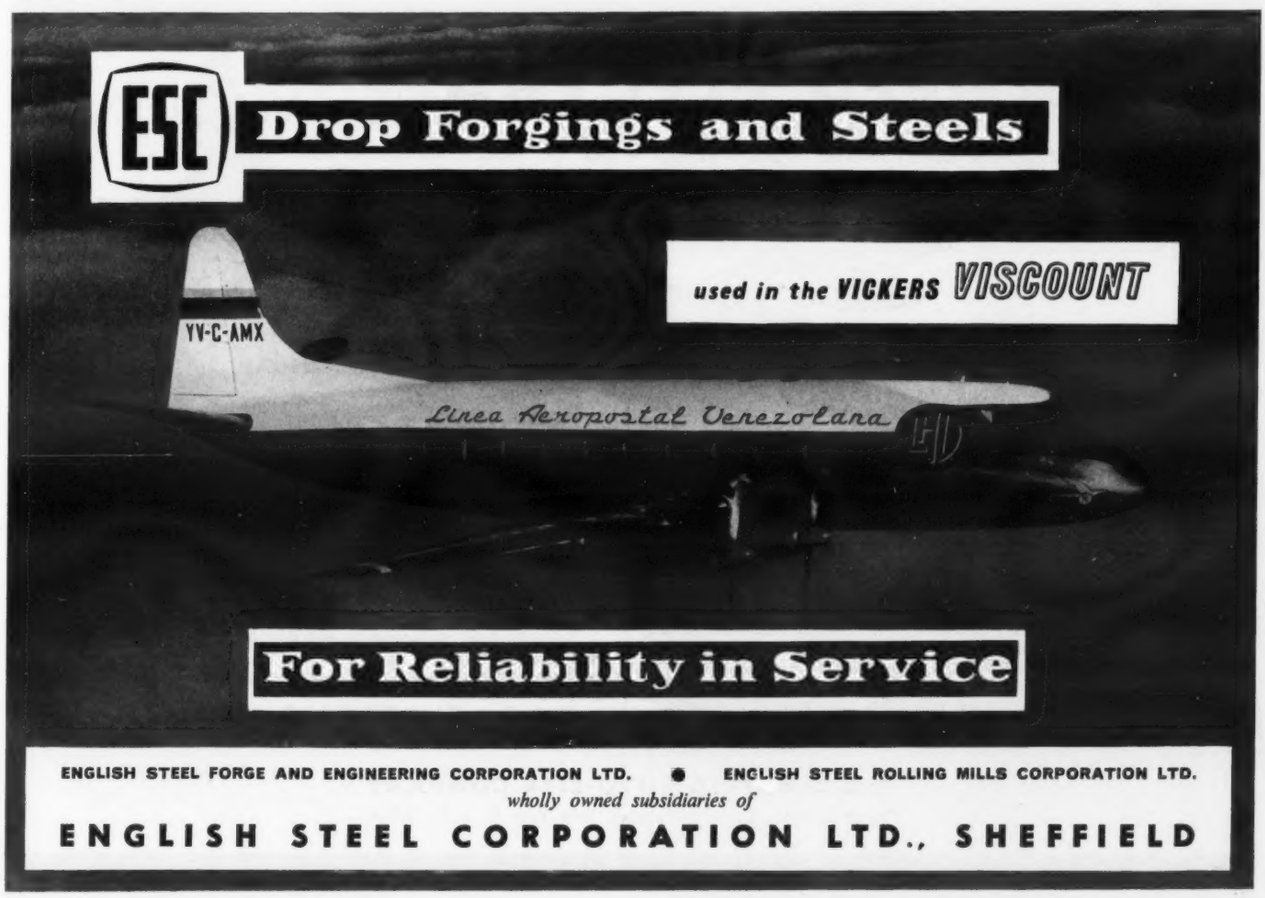
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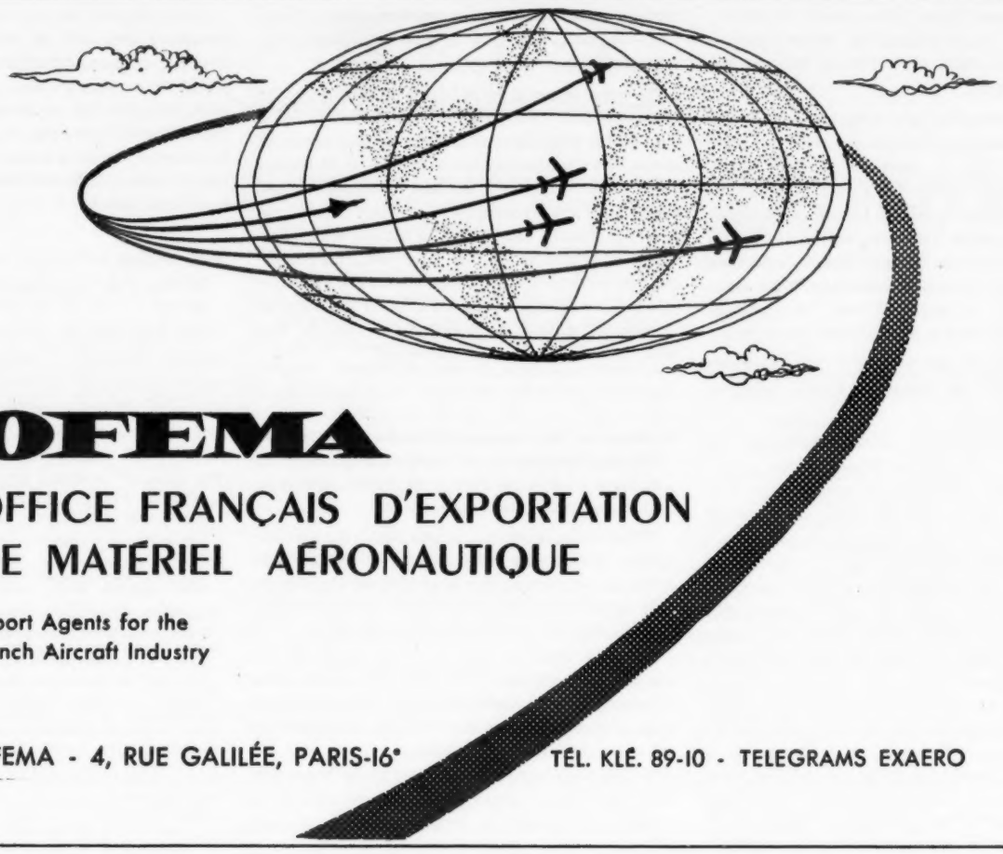

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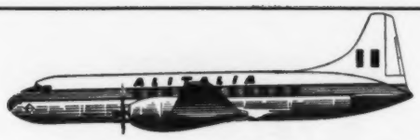

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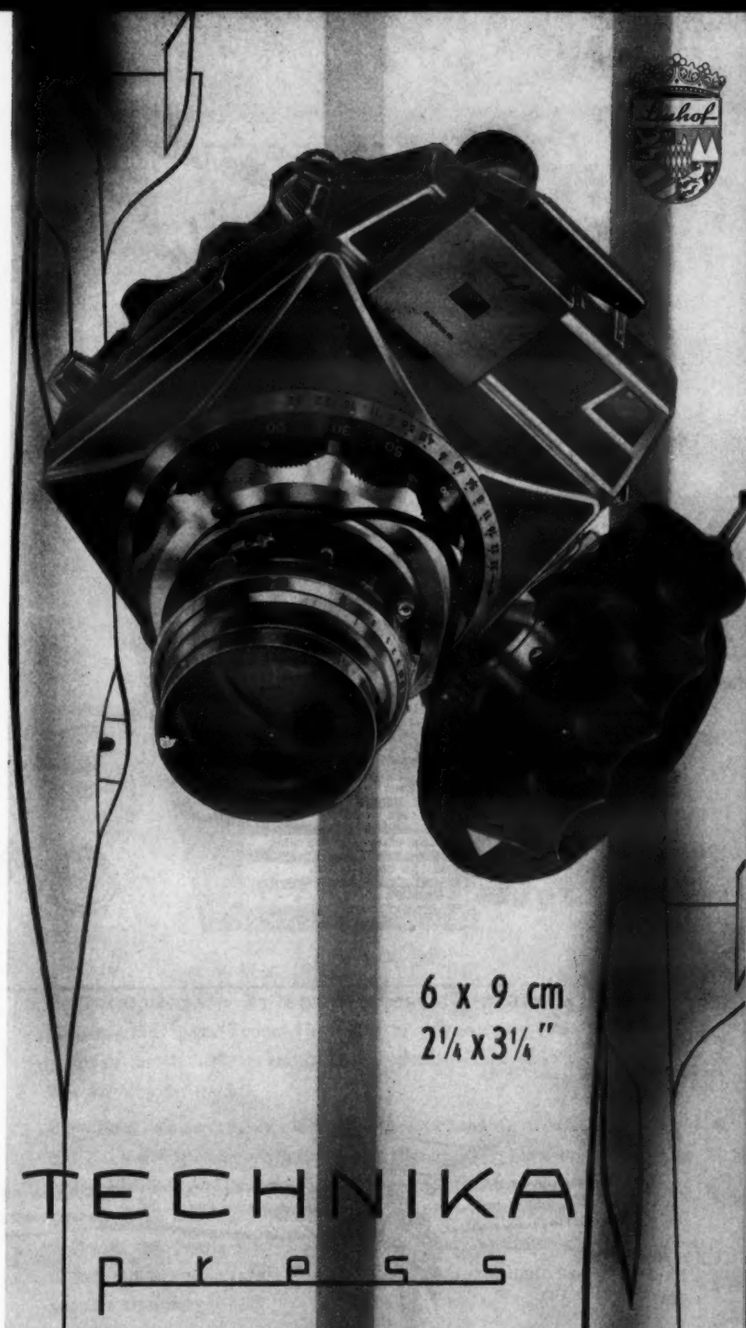

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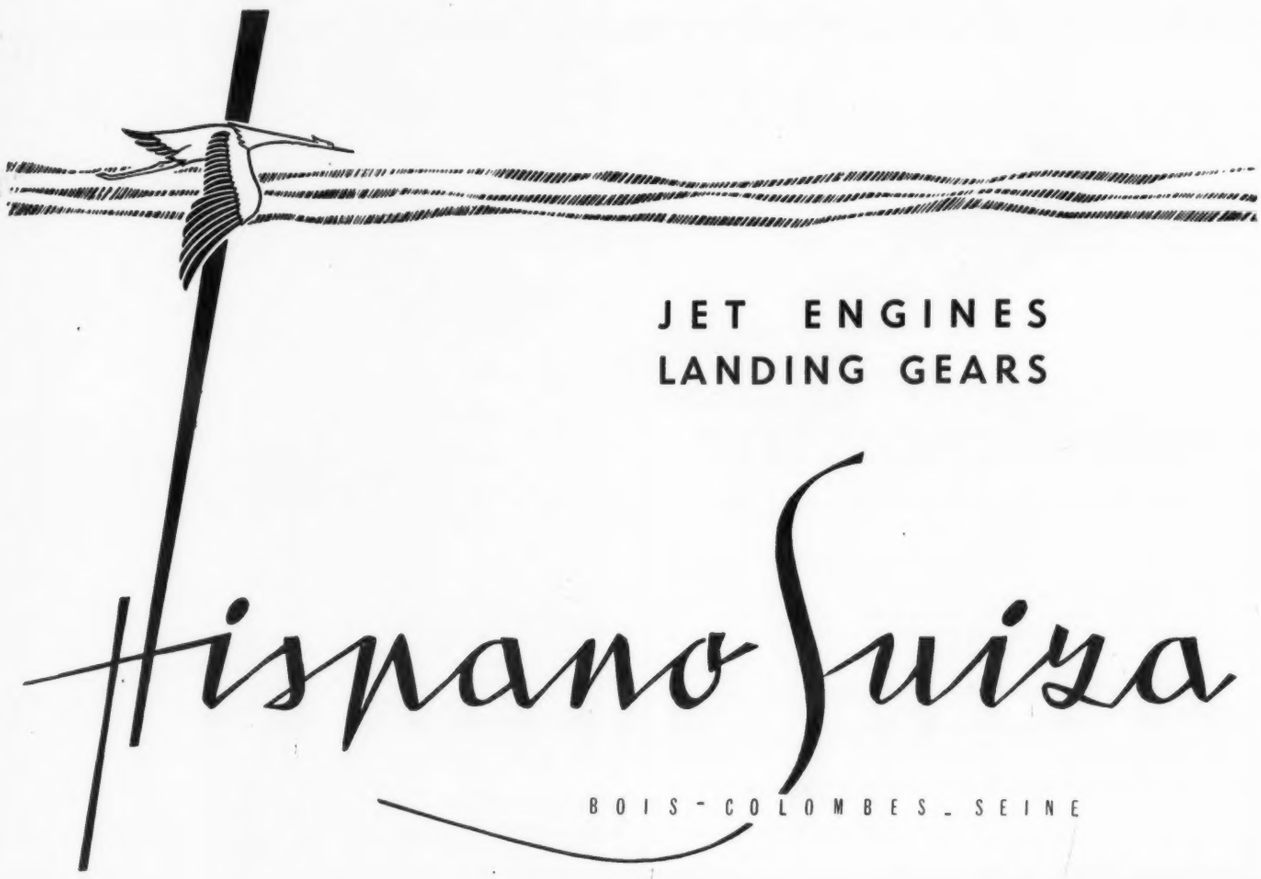

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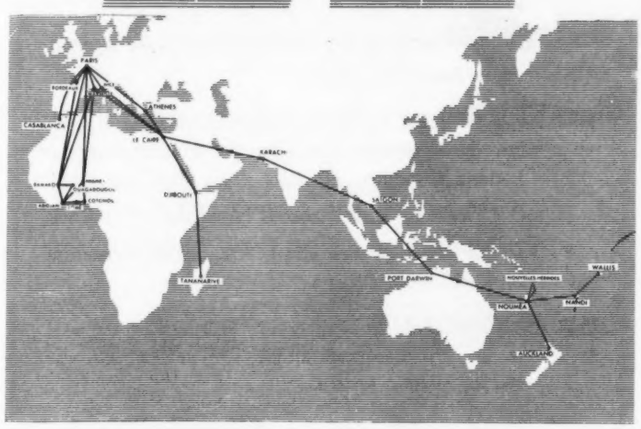

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For further information on the TT-1, contact

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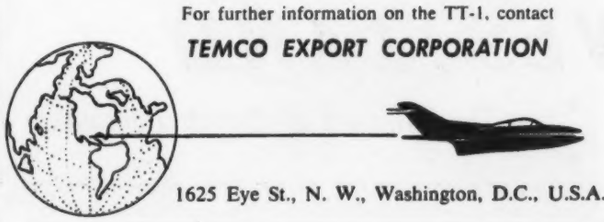

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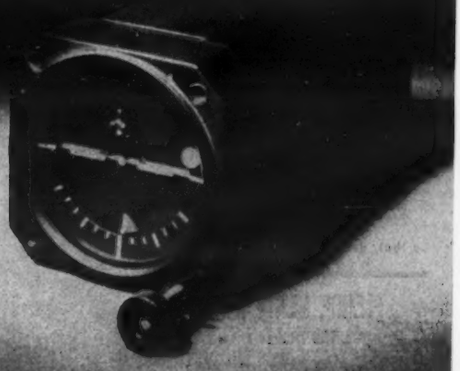

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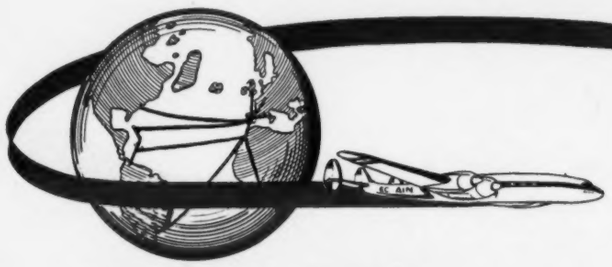

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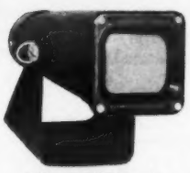
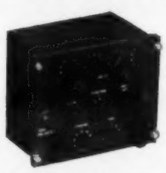


7,62 cm display for instrument panel mounting.



Small, panel - mounted command control provides directly-read data. Receiver unit (not shown) occupies 3/4 ATR rack.

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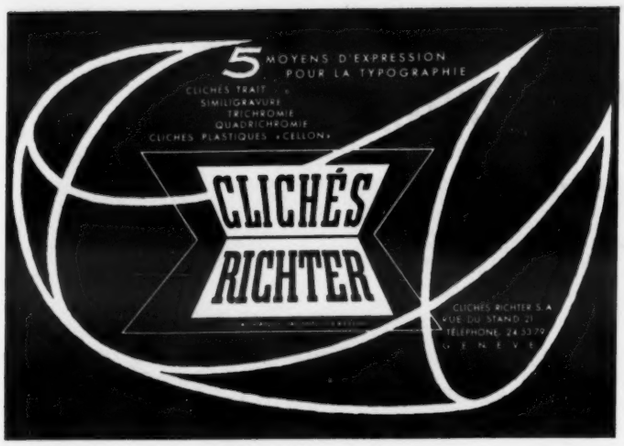

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	Page
Aerfer, Pomigliano d'Arco	351
Air Algérie, Paris	353
Air France, Paris	269
Aircraft Radio Corp., Boonton	352
Alitalia, Rome	345
Allison Division of General Motors, Indianapolis	283
Avro Canada Ltd., Malton	258
Bendix International, New York	326, 327
Boeing Airplane Co., Seattle	271
Breguet, Paris	353
Bristol Aeroplane Co. Ltd., Bristol	328
Canadair Limited, Montreal	356
Cointrin Airport, Geneva	288
Contraves Italiana S.p.A., Rome	261
Costruzione Aeronautiche Giovanni Agusta, Cascina Costa-Gallarate	350
Decca Navigator Co. Ltd., London	274
Edo Corporation, College Point	352
Electric Autolite, New York	344
English Electric Co. Ltd., London	279, 292
English Steel Corp. Ltd., Sheffield	349
Fairchild Engine & Airplane Co., Hagerstown	303
Fairey Aviation Co. Ltd., Hayes	263
Fiat S.p.A., Turin	268
Flight Refuelling Ltd., Tarrant Rushton Airfield	349
Fuller & Co., San Francisco	289
Garrett Corp., Los Angeles	290
Goodyear Tire & Rubber Co., Akron	291
Hispano-Suiza, Bois Colombes	346
Hollandse Signaalapparaten N. V., Hengelo	346
Hunting Percival Aircraft Ltd., Luton	277
Iberia, Madrid	352
KLM Royal Dutch Airlines, The Hague	348
Kloten Airport, Zurich	272
Lear Inc., Santa Monica	278
Linee Aeree Italiane, Rome	348
Linhof K.G., Munich	345
Lockheed Aircraft Corp., Burbank	284, 285
Marconi's Wireless Telegraph Co., Chelmsford	287
Messier, Paris	302
Minnesota Mining & Mfg. Co., St. Paul	281
Napier & Son Ltd., London	280
OFEMA, Paris	344
Omnipol S. A., Prague	264
Orenda Engines Ltd., Malton	301
Paris Airport Authority, Paris	355
Potez, Paris	352
Radio Switzerland, Berne	345
Resistoflex, Roseland	282
Richter S. A., Geneva	354
Rolls-Royce Ltd., Derby	325
SAGAT, Turin	354
Schwitter S. A., Basle	354
SFENA, Neuilly	348
SNCA du Nord, Châtillon	286
SNECMA, Paris	260
Sofrance S. A., Limoges	350
Strüver G.m.b.H., Hamburg	351
Sud-Aviation, Paris	265, 266, 267
Swissair, Zürich	270
Sylvania International Division, New York	304
TAI, Paris	347
Telefunken G.m.b.H., Berlin	273
Temco Export Corp., Washington	347
Textiglass, Paris	350
UAT, Paris	259
Westland Aircraft Ltd., Yeovil	343

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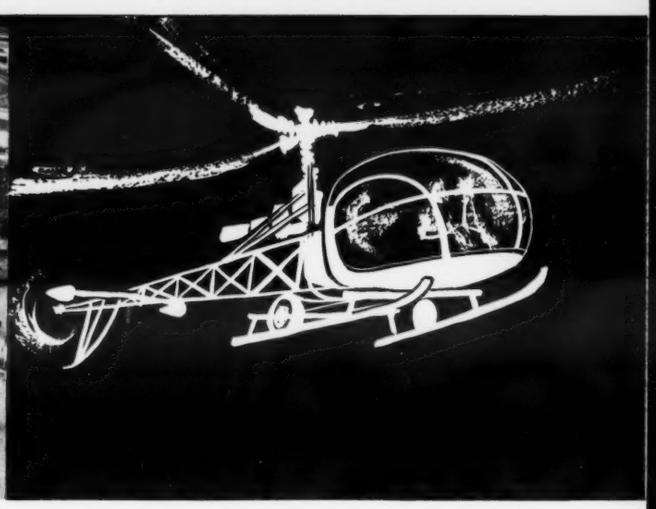

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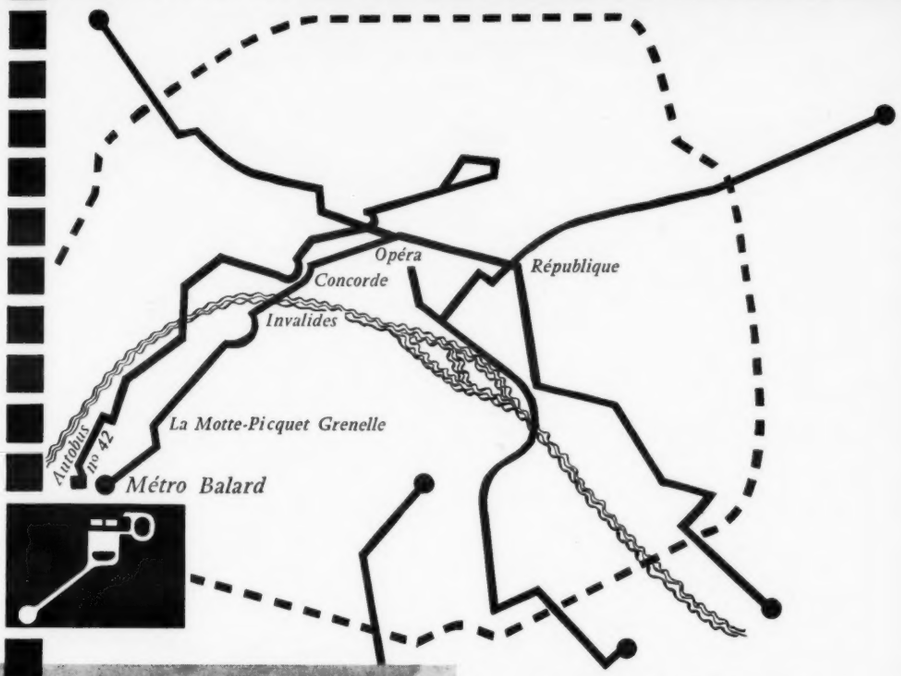

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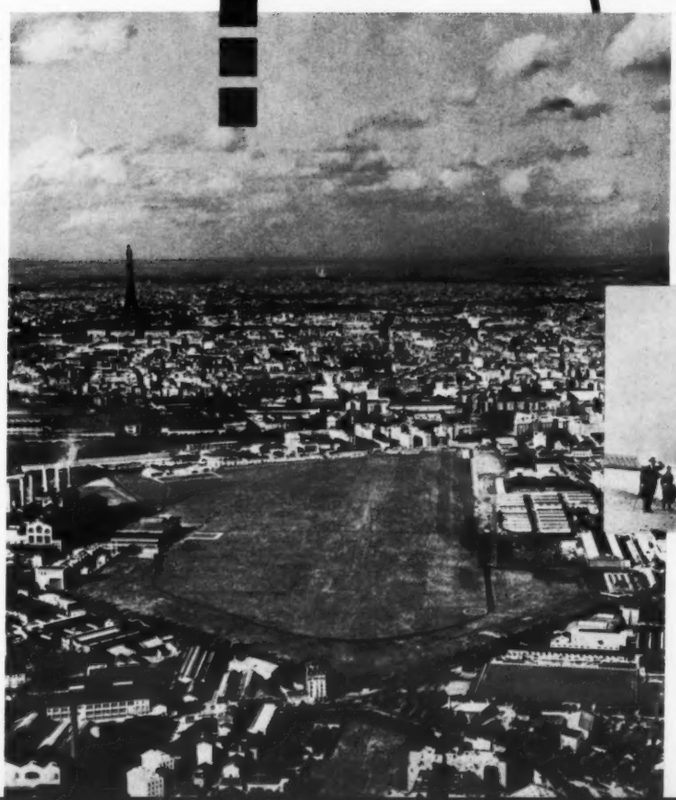
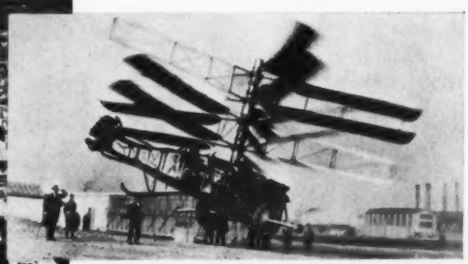
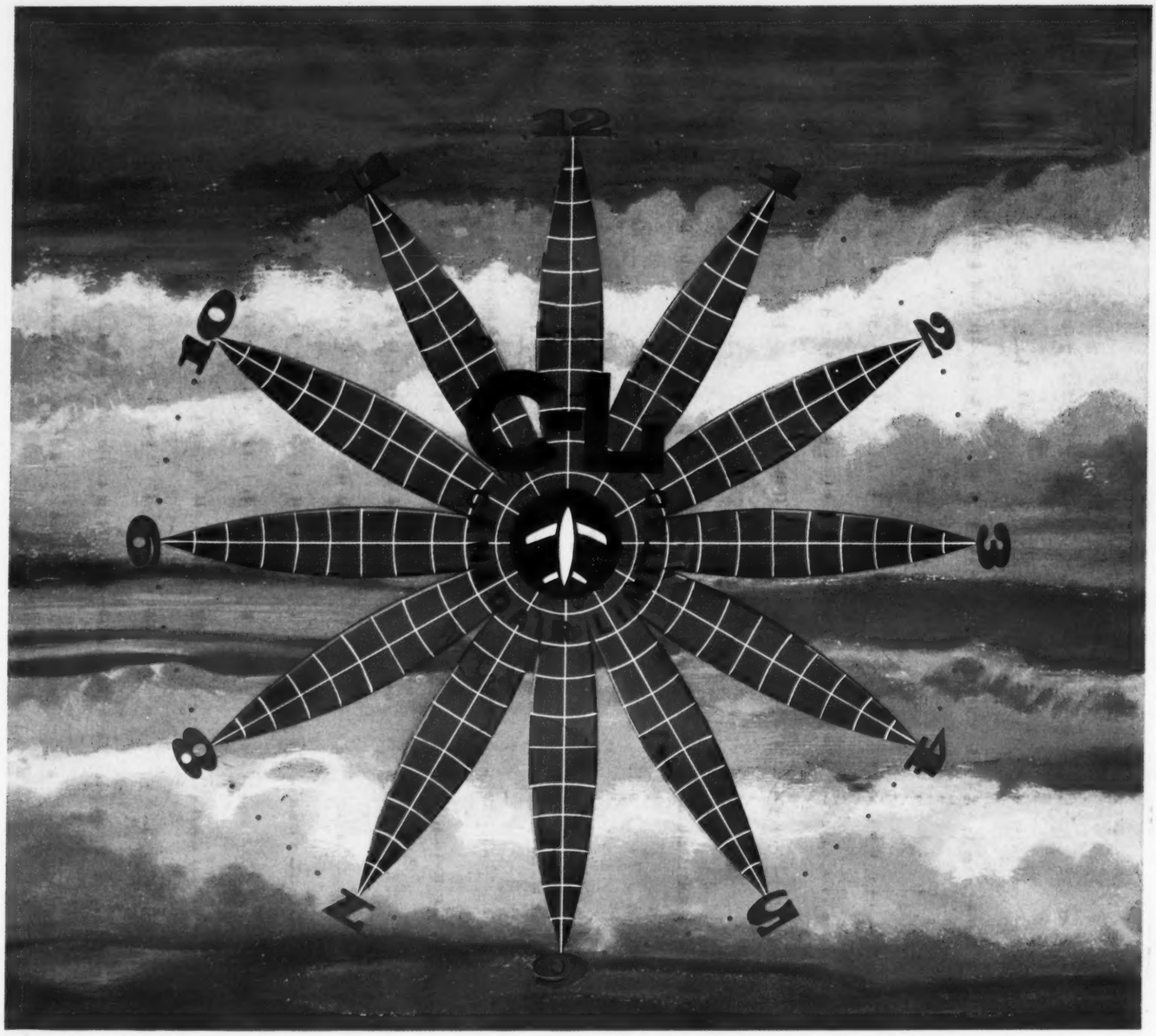


Aerial view of Paris-Issy heliport



The Marquis of Pescara's helicopter (May 7th, 1923)



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